INCIDENCE OF CORONARY HEART DISEASE IN A POPULATION INSURED FOR MEDICAL CARE (HIP)

Myocardial Infarction, Angina Pectoris, and Possible Myocardial Infarction

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I. BACKGROUND AND METHODOLOGY

In 1961 the Health Insurance Plan of Greater New York (HIP) initiated research directed primarily toward the development of prognostic information on newly diagnosed manifestations of coronary heart disease (CHD). A secondary but important interest was to derive incidence rates for myocardial infarction and angina in a large defined population in relation to a number of personal and social characteristics.

Preliminary incidence rates from the HIP study, based on the first 18 months of case finding, have been published.[1] This report will present the final rates, derived from three years of case finding in the study population of some 110,000 adults. Annual rates of incidence of myocardial infarction, angina, and possible myocardial infarction for men and women aged 35-64 are shown in relation to a wide range of variables. Age, sex, smoking habits, physical activity, categories of body weight, color, religion, place of birth, occupation and work status, education, and marital status will be discussed.

The usual methodology of studies designed to develop incidence data for chronic diseases consists of observations on very large populations, or, alternatively, observations on a comparatively small population repeated over a long period of time. Special circumstances in the HIP setting made it possible to take an approach which did not depend on repetitive examinations of both sick and well persons to locate new cases of CHD. These included the availability of a population register, the existence of a well-developed and tested system of reports of physician services to individuals, and ready access in central locations to the complete set of medical charts prepared by HIP physicians for members of the Plan. The study has taken full advantage of these conditions, and has supplemented them with standard physical and laboratory examinations for selected categories of the HIP adult membership and with medical record information from sources outside HIP.

The Study Population

Enrollment in HIP is on a group basis. During the period of the study about 65 per cent of the members were in the Plan through group contracts with local, state, and federal agencies. The next largest source of enrollment consisted of union welfare funds, which account for about 20 per cent of the membership. In return for a premium HIP members are entitled to receive comprehensive medical care from physicians associated with 31 affiliated medical groups. Coverage is for preventive and diagnostic services, as well as for therapy of specific illness, from family physicians and all types of specialists. These services are rendered in the doctor's office, the home, and the hospital. All enrollees are required to carry hospital insurance.

The population under observation for the CHD study consisted of adults aged 25-64 (110,000-120,000 persons) enrolled in 15 medical groups of the Plan. (For incidence rates the study population is limited to ages 35-64 years.) To be eligible for the study these members were required to have been enrolled continuously in HIP for at least two years. Experience indicates that such persons have a greater commitment to the Plan than comparatively new members and are likely to remain in the program for long periods of time. Also, the overwhelming majority have had repeated medical contacts with HIP physicians.

The participating medical groups* are distributed throughout four boroughs in New York City (Bronx, Brooklyn, Manhattan, and Queens), and their populations cover a wide range of socioeconomic, ethnic, and religious groups. (See Appendix C, Table C1, for distribution of the study population by demographic characteristics.) Like the population of HIP as a whole, however, the study population cannot be considered representative of all of New York City. For example, a smaller proportion of HIP's membership were in the lowest socioeconomic groups; also, while nonwhites in HIP constituted about the same proportion of the membership as in the general New York City population (12 per cent), there were comparatively few Puerto Ricans in the Plan.

Criteria for Diagnosis and Classification of Manifestations of CHD

A detailed description of the rationale underlying the classification system adopted for the study, and the specific criteria, sources of data, and operational rules have been previously reported.[2] Because of the study's interest in prognostic information a wide range in diagnostic specificity was covered—from highly specific criteria for myocardial infarction to defined entities characterized as "possible angina" or "conduction defects."

Interest in incidence of new manifestations of CHD is focused on a narrower diagnostic range, and this report is limited to data for *definite myocardial infarction, definite angina,* and *possible myocardial infarction.* Details on the inclusions in these categories are provided in Appendix A. Rates and numerator frequencies are to be presented for "Definite MI" and for two subgroups of this category defined in relation to whether death occurred within 48 hours of onset. The patients with rapidly fatal MIs (within 48 hours) are for the most part persons meeting the study's criteria for "new coronary event leading to death" (NCE). These are patients whose death occurs under circumstances suggesting that death was caused by a new MI or coronary occlusion without infarction, but ECG and clinical data required to meet the study criteria for "highly probable" or "probable" MI are not available, usually because of the short interval between onset of symptoms and death. A small number of patients who survive to hospitalization and meet the necessary ECG and clinical criteria but who nevertheless succumb within 48 hours constitute the rest of the "rapidly fatal" group. The patients experiencing these rapidly fatal MIs can be viewed as roughly equivalent to the "sudden death" groups shown by other investigators in epidemiologic studies of coronary heart disease. The other definite MI subgroup consists of patients surviving more than 48 hours and meeting the study criteria for "highly probable" or "probable" MI.

The incidence data presented for "angina" are limited to patients meeting the study criteria for *definite* angina for the first time in the three years of case finding for incidence. The assignment of patients to this category is based on a detailed medical history taken at a baseline evaluation examination, without regard to ECG findings at rest or after exercise. Such patients have never previously sustained an MI and are free of aortic valvular disease. Application of a uniform set of scores to the detailed record of recurrent symptoms which have lasted a minimum of two months results in a cumulated total score acceptable as "definite" angina (see Appendix A).

The diagnosis of "possible MI" covers a number of combinations of ECG,

* The 15 medical groups were selected on the basis of their interest in the study, geographic distribution, and heterogeneity of population. Three of the groups contributed to the study population only during the last year of the three-year case-finding period for the incidence phase (November 1, 1961-October 31, 1964).

clinical and symptomatic findings, many of which are equivalent to the "coronary insufficiency" designation used in some other studies. At the extremes of the distribution of these cases there are, on the one hand, cases that other investigators would probably have categorized as "myocardial infarction" and, on the other, some sufficiently equivocal to have been omitted from other classification schemes. Two-thirds of the patients classified as experiencing a first possible MI exhibited specified ECG abnormalities (see Appendix A, Table A4). Patients meeting the HIP criteria for "possible MI" who, in addition, met the study criteria for *angina* within two months preceding or following the possible MI episode are counted *only* in the incidence rates for angina.

Case-Finding Procedures

The objective of case-finding procedures, as related to the development of incidence data, was to locate all patients in the study population who met the study criteria for myocardial infarction, angina, or possible myocardial infarction for the first time in the three years beginning November 1, 1961, and to obtain information on a number of personal and demographic characteristics of interest in the search for factors associated with relatively high or low risk for incidence.

a. *Screening of Physician Service Reports (Med 10's)*

The initial screen for locating new cases was the report of medical service prepared by all physicians in HIP as patients are seen. These reports, referred to as "Med 10's," identify the patient (name, certificate number, sex, birth date, and family status) and give the date, place and type of service, and the diagnosis. Each month a CHD study staff member scanned Med 10's for the previous month to locate and list patients not previously identified for whom there was a diagnosis suggestive of or possibly associated with coronary disease. A broad list of medical terminology was used for this purpose. Many of the terms included were not in themselves descriptive of CHD, but they were included in the initial screening process to reduce the likelihood of missing study cases. The final screening list was adopted after systematic testing of the effect of including and excluding selected groups of terms.

For all patients listed as a result of this monthly Med 10 screening an abstract of all HIP medical service, including clinical and laboratory information, was prepared from the HIP medical charts on a structured form designed for the CHD study. These abstracts were reviewed and classified centrally by study staff under the supervision of the study's medical director in order to identify the patients to be examined and evaluated. Specific criteria for classifying medical record data at this stage of the screening procedure were established.

Patients suspected of having a new manifestation of CHD after review of the medical record abstract were listed for baseline evaluation examination. All other patients for whom medical record abstracts were reviewed were classified as (1) "returned to risk" (with either no suggestion of CHD or with some manifestation other than MI diagnosed before the study period), or (2) "excluded" from the population at risk (because of an MI prior to the study period or because of the presence of aortic valvular disease). Questionable situations were resolved in favor of bringing the patient in for a baseline examination.

Family physicians of all patients to be evaluated were notified and given a five-day period in which to communicate any special information or circumstances they wished the study staff to have. Patients were then informed about the study through correspondence and telephone communication from study staff, and appointments for the baseline examinations were set up. Cooperation in appearing for the baseline examination was obtained from 90 per cent of those invited. Response rates varied with the specificity of the suspected new CHD manifestation—93 per cent for MI, 89 per cent for angina, and 87 per cent for possible MI. In the case of patients refusing evaluation for whom the medical record abstract (of both in- and outpatient service) fulfilled study criteria for myocardial infarction ("highly probable" or "probable") a special telephone interview was sought to obtain information on characteristics at time of diagnosis. Such interviews were completed in 89 per cent of these refusals. When patients died before a baseline evaluation could be scheduled, an interview was conducted with the next of kin to obtain information on the circumstances of death, hospitalizations and other sources of medical care not already known, and personal characteristics of the type covered by the questionnaire for patients who receive a baseline examination.

Baseline evaluation examinations were carried out during special sessions in each participating medical group by a board-certified or board-eligible internist who had been indoctrinated on procedures to be followed. A detailed medical history was entered on a highly structured form, designed to cover fully any prior history of CHD, medical care received for these complaints in and out of HIP, hospital episodes, signs and symptoms related to cardiovascular disease, limitations of functional capacity, and the presence of other diseases that might account for any symptoms noted or that might be of importance in describing the course of a manifestation of CHD. A physical examination was performed and a standard 12-lead electrocardiogram obtained. A blood sample was drawn for lipid determinations performed at a central laboratory and for a casual blood sugar determination.

During the baseline evaluation sessions a trained study staff member conducted a nonmedical interview with each patient. The questionnaire inquired about a wide variety of personal characteristics—age, sex, race, religion, education, place of birth, occupation, physical activities both connected with the job and off the job and any limitations on physical activity, smoking practices, and weight changes during adult life. Historical information was obtained for parameters that vary with time to provide the basis for classifying the patient as of the date of diagnosis (on the average, less than six months before evaluation) for use in incidence rates.

The clinical findings of the special examination and abstracts of hospital charts for each evaluated patient were reviewed by the study's medical director; all ECG tracings were independently interpreted both by the study's electrocardiographer and a study staff physician. All evaluated patients were then classified in accordance with the study's criteria. Patients meeting the criteria for new manifestations of CHD were included in the prognosis cohorts and, in the case of myocardial infarction, angina, and possible myocardial infarction, they were counted in the appropriate numerator for incidence rates. Patients failing to meet these criteria were either "returned to risk" or "excluded" from the population at risk. HIP medical charts for certain categories of patients in the former group were reviewed and abstracted periodically to determine whether new medical information suggested that the patient should have another evaluation examination. All patients "returned to risk" were included in subsequent screening of physician reports and scheduled for another examination if new CHD diagnostic terminology appeared on the Med 10's.

b. *Additional Sources of Case Finding*

Supplementing the basic case-finding methodology described above were two other important sources. All notices of termination of enrollment in HIP were systematically reviewed to identify deaths among the study population. Copies of death certificates were obtained for all these persons, and medical charts abstracted whenever any cardiovascular terminology appeared on the certificate. Next of kin interviews were carried out in all cases where the possibility of a new coronary event was suggested by the death certificate or other medical information. Additional data were obtained from medical examiner records, hospital charts, and physicians not associated with HIP. Finally, the study's medical director classified all such patients in accordance with study criteria. In order to check on the completeness of death information computer tapes containing name, month and year of birth, sex and borough of residence for all persons in the HIP study population were matched against tapes prepared from New York City death records (and notices of deaths of residents occurring outside the city) for the first year of the case-finding period.[3] Some missed deaths were located in this way, but the increment to CHD incidence rates was not judged sufficient to warrant continuing the matching procedure for the rest of the case-finding period.

The other important supplementary case-finding source consisted of punch card files representing hospital claims for cardiovascular episodes among the Plan's membership. These files were systematically checked, throughout the case-finding period, against the file of patients identified through the Med 10 screening and death search mechanisms. For all patients not already known to the study, medical records were abstracted and, where necessary, information from physicians outside HIP was obtained through correspondence and telephone contact made by the medical director. Decisions on patients to be scheduled for evaluation were then made in the same way as for those patients identified through the usual Med 10 screening mechanisms.

Population at Risk for New Manifestations of CHD: The Mail Survey as the Source of Denominator Data for Incidence Rates

Adult members of the HIP medical groups participating in the study—about 110,000 persons—who were 25-64 years of age and had been continuously enrolled in HIP for at least two years constituted the population under observation. To facilitate comparison with data from other investigations the incidence data to be presented have been limited to the population aged 35-64. The HIP population is defined as a constantly changing community rather than a cohort, and the incidence rates measure the average experience of a community which has a moderate amount of population movement.

To determine the characteristics of the population at risk for specified manifestations of CHD a mail survey of a 4 per cent random sample of the adults in the participating medical groups was conducted in April of each of the three years 1962, 1963, and 1964. The mail survey questionnaire covered demographic and environmental factors of interest in studies of CHD incidence. In addition, the questionnaire inquired about past diagnoses of heart disease, the occurrence of chest pain on effort, and related items. Medical charts in HIP were reviewed for respondents who gave a positive response to these questions, and this abstracted medical information was used to decide whether the individual should be excluded from the population at risk for a specified manifestation of CHD.

The criteria applied were the same as in the review of medical chart data during the case-finding operation described above.

Each year's mail survey sample was independent from that in previous years, so that almost 12 per cent of the adult enrollees were covered in the three surveys combined. After removal of the respondents defined as no longer at risk for a specified CHD manifestation, the resultant data for a given survey were viewed as descriptive of the average population exposed to risk over the year extending from the November preceding the given survey through the October following it. The rates presented in this report are based on the combined experience of all three years—the appropriate denominator for case finding extending from November 1, 1961, through October 31, 1964.

Since different instruments are used in this study to obtain information for the numerators and the denominators entering into rates of incidence of CHD, the possibility of systematic bias in constructing the rates is an issue of some importance. Such bias could be introduced by the nonresponse to the mail survey or by lack of comparability between data collected from the two sources with respect to variables used in examining the incidence data. A detailed examination of these questions is made in Appendix C.

The over-all response for the three mail surveys combined was 83 per cent, with little variation between the years (83.0 per cent for 1962, 83.8 for 1963, and 82.2 for 1964). The first wave of respondents constituted 72.4 per cent of the total sample, and in all three years a 25 per cent sample of the original nonresponse was subjected to intensive follow-up by letter, telephone, and home visit. To explore possible bias introduced by the nonresponse, the characteristics of the two waves of respondents in the 1962 and 1963 surveys were examined separately. The differences found are summarized in Appendix C. If it is assumed that the 17 per cent nonresponse has the characteristics of the late respondents, the effect on the distribution of the surveyed population with respect to the variables examined for incidence rates is very small. This computation is shown for demographic characteristics, smoking, physical activity, and occupation in Appendix C (Tables C1, C2, and C3).

To examine the issue of comparability of data collected from mail survey and personal interview sources the study's methodology provided for comparison between mail survey responses and answers on personal interview for all those individuals in the cumulative mail survey sample who also, over the course of the study period, received a baseline evaluation examination because the possibility of a new manifestation of CHD was suspected. From February, 1962, through October, 1966, a total of 156 patients (104 males and 52 females) who were respondents to one of the three mail surveys also received a baseline examination. Comparison of the data from the two sources is described in detail in Appendix C.

Excellent agreement between mail survey and interview information on demographic characteristics—age, color, place of birth, religion, education—was found for both men and women, and there was also good agreement in the reporting of occupation on the part of the working men. Among men interviewed within 18 months following mail survey, or within six months preceding it, there was good agreement in the reporting of smoking habits, even when these habits were classified in detail by amount of cigarette smoking. When all men for whom the interview followed the mail survey, regardless of the time lapse, were included in the comparison, the degree of agreement was less, especially when a detailed classification was used. Comparison of information on physical activity from the two sources was done for a number of groups defined with respect to the time elapsed between the mail survey and the interview. A detailed discussion appears in Appendix C. Although some bias may have operated in the direction of overstating physical activities on mail survey, or understating them on interview, a reasonable estimate of the magnitude of such a bias does not suggest any important changes in the relationships to be discussed.

Sampling Errors

Tests of statistical significance have been applied systematically in all comparisons discussed in the analytical sections of the report. These tests take into account only sampling variability and are applied under the assumption that observations are drawn from an infinite universe.

Text tables and selected charts are annotated to indicate the probability that a difference at least as large as the observed is not explained by sampling variability. Three probability levels are used—0.99, 0.95, and 0.90. While the probability level of 0.90 is relatively weak, the odds are viewed as sufficiently high to call attention to differences that meet this criterion. A more detailed discussion of sampling errors and nomographs for determining standard errors appear in Appendix B.

II. SUMMARY DEFINITIONS APPLICABLE TO ALL INCIDENCE RATES

Criteria for the manifestations of coronary heart disease for which incidence data are given in this report appear in detail in Appendix A. The category *myocardial infarction* (MI) includes both cases meeting the study's electrocardiographic and clinical criteria for "highly probable" or "probable" MI and cases defined as "new coronary events leading to death." Rates are shown in the tables for the total category, for the rapidly fatal MIs (deaths within 48 hours), and for the remaining MIs. The rates for *angina* represent all cases meeting the study criteria for this diagnosis for the first time in the three-year case-finding period. The diagnosis is based on evaluation of the medical history only, without regard to ECG findings with the patient at rest or after exercise. Patients with antecedent myocardial infarction who develop angina for the first time are excluded from these rates. But patients who in addition to angina also met the study criteria for a diagnosis of *possible MI* (either before or during the case-finding period) are included in the incidence rates for angina. The rates for *possible MI* represent cases meeting the study criteria for this diagnosis in the three-year case-finding period who had never sustained a diagnosis of "highly probable" or "probable" MI and who did not sustain a diagnosis of angina within two months before or after the date of possible MI. Persons diagnosed as both angina and possible MI within a period of two months are counted only in the numerator of the rates for angina.

III. AGE AND SEX

The average annual incidence rate of first myocardial infarction among men aged 35 to 64 is 5.2 per 1,000, with 32 per cent of the episodes rapidly fatal (deaths within 48 hours). The well-known disadvantage of men in comparison with women is apparent, with the rate for males over five times that for females (1.0 per 1,000). The higher incidence among men is of the same order of magnitude both for the rapidly fatal MIs and for all others. Both the incidence of angina and of possible MI among men (2.0 and 1.2 per 1,000, respectively) are about twice the corresponding rates for women (0.9 and 0.6 per 1,000).

The expected sharp increases in incidence with increasing age are found in both sexes for all three manifestations (Table 1 and Figure 1), and are shown graphically for MI and angina by five-year age groups in Figure 2. After age 44 the rate of increase is greater for women than for men, as indicated by the steeper slopes of the incidence rate curves for females. When incidence is examined by decades, the MI rate among women 45-54 is almost ten times that for women 35-44, and that for women 55-64 is about four times that for women 45-54. Among men aged 45-54 the incidence of first MI is about four times that for the youngest age group, while that among the oldest men (55-64) is 1.7 times the rate for men aged 45-54.

In spite of the more rapid increase in the rates for women as age advances, the incidence of each of the three manifestations among the oldest age group here studied—55 to 64—is still very much higher in men than in women. Thus in this age group the incidence of MI for males is 3.5 times that for females, while the rates for angina and possible MI are almost twice as high among men as among women. As an approximation, these data suggest that women reach the level of incidence of first MI shown by men at an age about 15 years later; for angina, the advantage of the women may be estimated as an interval of seven to eight years before the rates for males are reached (see Figure 2).

The excess burden imposed by myocardial infarction among men can also be expressed by the relationship between the incidence rates for the three manifestations of CHD under consideration (Figure 2 and Table 1). For men as a whole, incidence of first MI is 2.6 times the incidence of angina and 4.4 times the incidence of possible MI; these ratios are highest among the youngest men and decrease somewhat with age. In contrast, among women the incidence of MI is about the same as that of angina and only 1.6 times the rate for possible MI.

Comment

In his comprehensive review of the epidemiology of coronary heart disease Epstein[4] has summarized age-sex specific incidence rates for "coronary heart disease" from a number of studies. He noted the considerable variations among different investigations at given age ranges, and remarked on the possible role of varying diagnostic criteria and methods and of the sizable standard errors of the rates. In Table 2 age-sex specific rates for first myocardial infarction are shown for the HIP study and for two other studies in the United States with different methodologies and quite different population characteristics. Average annual incidence rates have been estimated for the ten-year age groups from Pell's study of the employees of the du Pont corporation,[5] and the 12-year incidence rates from the Framingham study[6,7] for specified ten-year "age at entry" groups (which approximate the HIP age groupings if averaged over this period) are shown as annualized rates. The outstanding feature of these data is the remarkable similarity among almost all the age-sex specific rates for MI (Table 2), despite the differences in methodology and population composition.

Interpretation of rates for incidence of CHD manifestations other than myocardial infarction from this or other studies, and of the comparability between such rates, presents a more complex problem. Both criteria for diagnosis and the methodology of a given study influence such rates greatly. In the HIP study a patient can sustain a diagnosis of *angina* for the first time if (1) he is free of aortic valvular disease and has never met the study criteria for myocardial infarction; (2) he is receiving routine medical care from a HIP physician who reports one or more services in diagnostic terms covered by the study's broad screening checklist; (3) the abstract of his HIP medical care sug-

Table 1—Average annual incidence of specified manifestations of CHD, by age and sex

Age and sex	Myocardial infarction Total	Died within 48 hrs	Other	Angina	Possible MI
		Rate per 1,000			
Males, total	5.20	1.67	3.51	2.03	1.19
35-44	1.42	0.31	1.11	0.46	0.24
45-54	5.54	1.61	3.93	2.10	1.10
55-64	9.39	3.46	5.93	3.93	2.52
Females, total	1.00	0.35	0.65	0.92	0.62
35-44	(0.07)#	(-)#	(0.07)#	(0.11)#	(0.07)#
45-54	0.68	0.28	0.40	0.80	0.54
55-64	2.68	0.90	1.78	2.16	1.48
		Number of cases			
Males, total	613	199	414	233	147
35-44	59	13	46	19	10
45-54	234	68	166	86	45
55-64	320	118	202	128	82
Females, total	129	45	84	118	80
35-44	3	-	3	5	3
45-54	34	14	20	40	27
55-64	92	31	61	73	50

Numerator frequency less than 10.

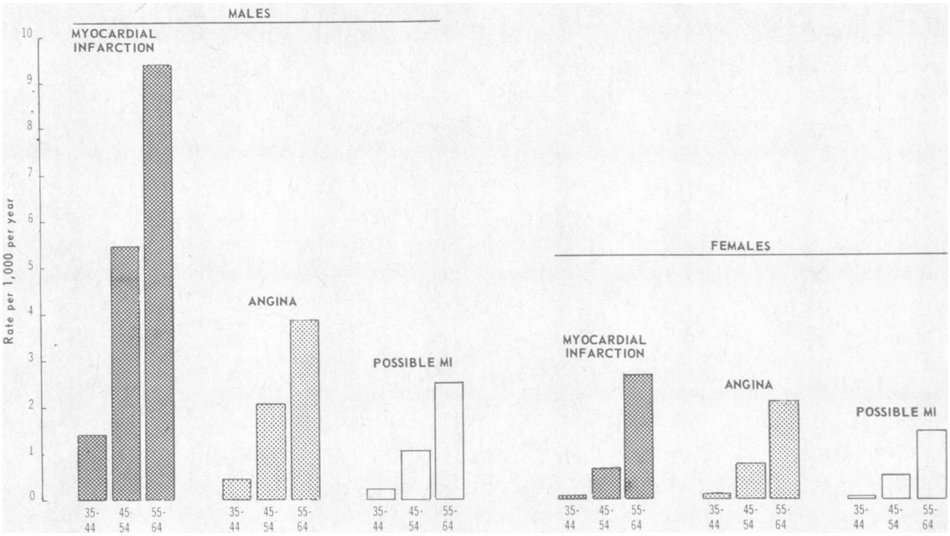


Figure 1—Average annual incidence of specified manifestations of CHD, by age and sex

gests the possibility of a new manifestation of CHD and leads to a decision to evaluate the patient at a baseline examination; (4) the patient accepts the invitation to a baseline examination; and (5) the description of symptomatology recorded by the examining physician at the baseline on being subjected to the study's standard system of scoring meets the criteria for chest pain acceptable as "definite" angina which has recurred over a minimum period of two months.

All of the above requirements operate toward producing minimum rates for incidence of angina as a new manifestation of CHD in the HIP study population. Patients who fail to seek medical care for their complaint, or who seek such care solely outside the HIP setting and are not hospitalized, or who refuse the baseline examination, or who develop recurrent chest pain on effort which disappears after an interval of less than two months cannot enter into the numerators of the study's angina incidence rates. Insofar as any information is available on the differential operation of the factors listed among men and women, the net result would probably overstate slightly the female rate in comparison with the male rate. That is, the somewhat higher general utilization of physician services by women in comparison with men and the lower rate of refusal of baseline examinations on the part of women would operate to produce less understatement of the incidence of new angina among women than among men. One can conclude that the rates shown in Table 1 show an over-all incidence of angina in men which is at least twice that found in women. The age-relationships of the angina incidence rates in both sexes parallel the findings for MI.

Further complexities are encountered when an attempt is made to judge the comparability of the findings on incidence of angina with those of other investigations. Although no similarly expressed annual rates of incidence of angina in relation to age and sex have appeared for an American population study, both the Framingham study[6,8-10] and the Albany study of male civil servants[11,12] have published some data on the incidence of angina. There is special interest in constructing a comparison of the HIP angina incidence rates with data from these two epidemiological studies. Early in the course of the HIP study the investigators at Albany and Framingham cooperated in a test of the HIP procedure adopted for classification of patients with angina. The HIP structured medical history form was used by them to record the history of complaints elicited from a group of patients in the Albany and Framingham studies. The histories were then processed at HIP in the usual way, and the final classification arrived at after scoring was compared with the judgments made by the Albany and Framingham

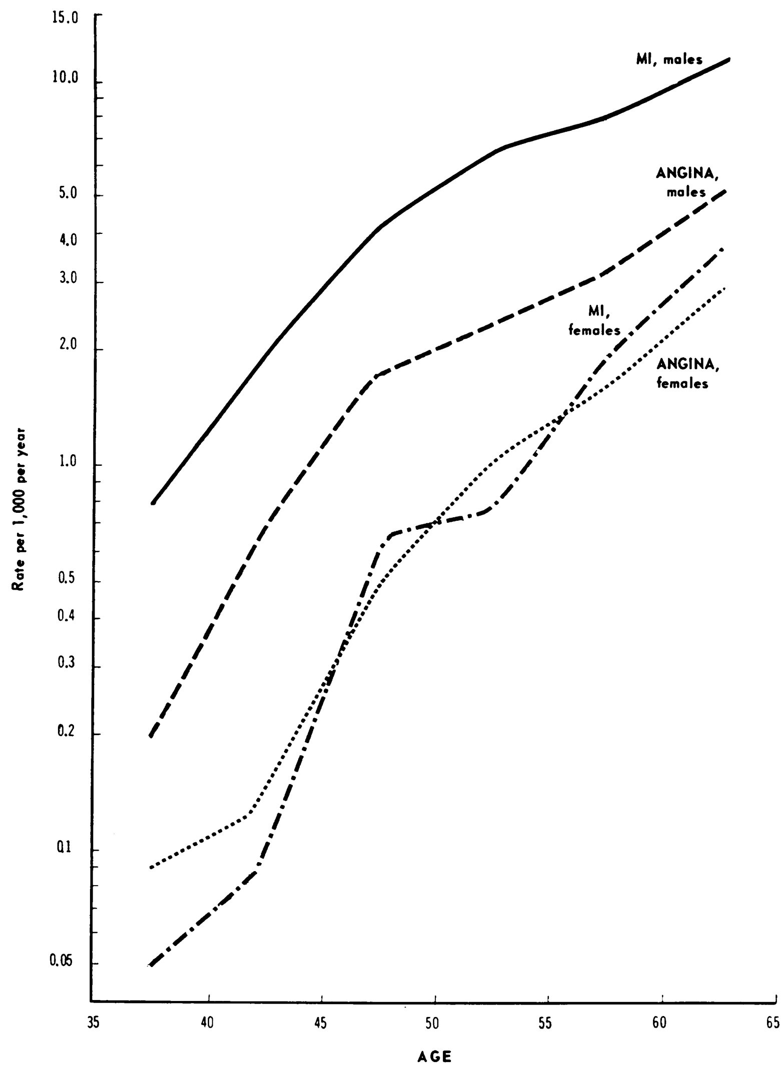


Figure 2—Average annual incidence of myocardial infarction and angina pectoris, by age and sex

Table 2—Average annual incidence of first myocardial infarction, by age and sex—comparison of three population studies

	Total cases	HIP Average annual incidence per 1,000 1962-1964 (3 years) Age at MI 35-44	45-54	55-64
Males	613	1.42	5.54	9.39
Females	129	0.07	0.68	2.68
		du Pont* Average annual incidence per 1,000 1956-1961 (6 years) Age at MI 35-44	45-54	55-64
Males	1316	1.67	6.12	10.55
Females	24	0.10	0.59	2.60
		Framingham** Average annual incidence per 1,000 1949-1961 (12 years) Age at entry 30-39	40-49	50-59
Males	164	2.83	6.17	10.67
Females	35	0.17	0.75	2.50

* Recomputed estimate from five-year age-specific data in Table 1 of Pell and D'Alonzo.[5]
** The rates shown have been annualized from the "12 year incidence" rates for "myocardial infarction" and "sudden death" combined, shown in Figure 5, Kannel, et al.[6] Total number of cases in 12 years as given in Kannel, et al.[7]

investigators for the handling of their own case material. Of 18 patients judged to have definite angina at Albany and Framingham, 17 were classified as definite angina by the HIP system, and one as possible angina. All 17 patients classified as angina at HIP were diagnosed as angina by the other studies. It is reasonable to conclude that the diagnostic criteria for angina produced comparable judgments from the three sources.

Problems in comparability between these studies nevertheless arise because of methodologies which accumulate new cases from relatively small populations over a long period of time in contrast with one which accumulates new cases from a much larger population over a relatively short period of time, as at HIP. The "12-year incidence" data for specified CHD manifestations in the Framingham study[6] are produced by unduplicated counts of persons in the numerators in relation to the persons considered free of CHD at the initial examination. Persons considered to have developed a CHD manifestation since the initial examination are classified in accordance with the following priority sequence[13]: myocardial infarction, coronary insufficiency, sudden unexpected death, CHD death not sudden, and angina pectoris alone. Estimates of an average annual incidence rate are therefore strictly possible from the published data only for the manifestation which has the highest priority—myocardial infarction. The Framingham staff has kindly provided us with recomputed 12-year rates for incidence of angina by age and sex in the absence of their usual priority sequence[13] so that, for example, a man sustaining a diagnosis of angina in Year 2 and an MI in Year 5 would still be counted in the numerator of the angina incidence. Under these circumstances the age-sex relationships for incidence of angina are similar at Framingham and at HIP:

Ratio of incidence rates for angina: males to females

Age at entry (Framingham)	Age at diagnosis (HIP)	Ratio (Framingham)	Ratio (HIP)
40–49	45–54	2.3	2.6
50–59	55–64	1.3	1.8

Ratio of incidence rates for angina: older to younger ages

Ages 50–59 to ages 40–49 (Framingham)		Ages 55–64 to ages 45–54 (HIP)	
Males	Females	Males	Females
1.6	2.7	1.9	2.7

The Albany study is restricted to men, and if the earliest incidence reports based on 31 months of experience for men aged 45-54 are annualized, a rate of 2.7 per 1,000 per year is obtained.[11] The corresponding HIP rate for men of this age was 2.1.

The category "possible MI" used in the HIP study can in a broad sense be viewed as approximating the category "coronary insufficiency" which has been used in other investigations. But reservations based on methodology and criteria must again be applied in relation to comparisons with other studies. There is a substantial group of patients whose first clinical expression of coronary heart disease is the development of recurrent angina on effort within a very short time (less than two months) preceding or following an episode which meets the HIP clinical and ECG criteria for "possible MI." In this report such patients are counted only in the incidence rates for angina, but the Framingham priority rules, for example, would assign such cases to the category "coronary insufficiency." However, some of the circumstances discussed above which might be expected to lead to minimum estimates of incidence for angina are not equally pertinent to the rates developed for possible MI. Most cases meeting the study criteria for this manifestation, like the patients who sustain a diagnosis of "highly probable" or "probable" MI, are hospitalized during the episode in which the specific clinical and ECG criteria are fulfilled. The diagnosis can therefore be established in accordance with study criteria even in the absence of a baseline examination.

IV. SMOKING HABITS

Data are presented with this report on the incidence of specified manifestations of CHD in relation to smoking habits for both men and women—by age, and age-adjusted (detailed Tables R1 and R11). Table 3 provides a summary of the age-adjusted rates.

Myocardial Infarction

Men who smoke cigarettes sustain a first myocardial infarction at an average rate of 7.0 per 1,000 per year in contrast with a rate of 3.3 among men who do not smoke. This twofold increase in risk is found both for rapidly fatal MIs and for episodes which do not result in death within 48 hours (Table 3 and Figure 3). A relative increase in risk for first MI of the same magnitude is found among women who smoke cigarettes in comparison with the nonsmokers, and, as with men, the excess risk among the smokers is shown both for rapidly fatal and all other first MIs.

The increased risk for MI among men who are heavy cigarette smokers in comparison with nonsmokers is especially pronounced, whether "heavy" smoking is defined as 1+ packs or 2+ packs of cigarettes daily (Table 3). Although the frequencies among women are in general too small to sustain detailed examination of incidence rates in relation to amount of cigarette smoking, the rates shown in the detailed table (R11) suggest that the excess risk for MI among women who are heavy smokers parallels that shown for men who habitually smoke large numbers of cigarettes.

Incidence of first MI among men who gave up cigarette smoking within the preceding five years is similar to that among other nonsmokers as well as to that shown by men who never smoked (Table R1).

The excess risk for MI experienced by cigarette smokers in comparison with nonsmokers is relatively greater among men and women aged 45-54 than among persons aged 55-64. Thus for men in the younger of these two age groups the ratio of MI incidence among cigarette smokers to that among nonsmokers is 3.1, in comparison with a ratio of 1.7 for the older men. The corresponding ratios for women are 2.9 for the younger age group and 1.8 for the older.

Among men who smoke pipes or cigars or both (pipe/cigar smokers), but no cigarettes, the incidence rate for first myocardial infarction falls between that for cigarette smokers and nonsmokers (Figure 3). Male pipe/cigar smokers experience an incidence of rapidly fatal MIs (deaths within 48 hours) which is about the same as that of nonsmokers; in contrast, their excess risk for all other MIs is very similar to that of the men who smoke cigarettes.

Angina Pectoris and Possible MI

A diagnosis of angina pectoris without prior MI is made almost twice as often among men who smoke cigarettes as among nonsmoking men—an incidence rate of 2.6 per year in cigarette smokers and a rate of 1.4 for nonsmokers. The excess risk for angina among the cigarette smokers is about the same as that for first MI. Moreover, in the case of angina the incidence among pipe/cigar smokers is about the same as that among cigarette smokers (2.4 per 1,000 per year). While the incidence of possible MI among male smokers (cigarettes or pipe/cigars) is somewhat higher than that for nonsmokers (1.4 and 1.0, respectively), the difference is only suggestive of statistical significance ($p<0.10$). Both in the case of angina and possible MI an excess risk associated with amount of cigarette smoking is suggested only when "heavy" smoking is defined as two or more packs of cigarettes daily. In contrast with the findings for MI, no relative disadvantage is apparent for younger smokers as compared with older men who smoke insofar as excess risk for either angina or possible MI is concerned. For men aged 45-54 the ratio of incidence rates of cigarette smokers to nonsmokers is 1.6 for angina and 1.3 for possible MI; for men aged 55-64 the ratios are 2.1 for angina and 1.3 for possible MI.

Among women no difference in relation to smoking is noted in the incidence of either angina or possible MI.

Comment

The current data confirm the well-documented association between cigarette smoking and coronary heart disease among men, summarized in the 1964 re-

Table 3—Average annual incidence of specified manifestations of CHD, by smoking habits and sex—age-adjusted rates per 1,000

Smoking habits; sex	Myocardial infarction: Total	Myocardial infarction: Died within 48 hrs	Myocardial infarction: Other	Angina	Possible MI
Males					
All cigarette smokers	7.01	2.34	4.67	2.62	1.36
2+ packs daily	20.80	6.53	14.27	6.64	4.05
1+ pack daily	7.62	2.38	5.24	2.59	1.29
Pipe/cigar smokers only	5.78	1.30	4.48	2.35	1.37
Non-smokers	3.27	1.17	2.11	1.37	0.95
Females					
Cigarette smokers	1.52	0.53	0.99	1.02	0.71
Non-smokers	0.75	0.26	0.48	0.85	0.57
Ratio of age-adjusted average annual incidence rates					
Males					
Cigarette smokers to non-smokers	2.1**	2.0**	2.2**	1.9**	1.4†
Pipe/cigar smokers to non-smokers	1.8**	1.1	2.1**	1.7*	1.4
Females					
Cigarette smokers to non-smokers	2.0**	2.0†	2.1**	1.2	1.2

NOTE: Confidence levels in the statistical significance of the difference between the two rates being compared are indicated by ** for 0.99, and * for 0.95, and † for 0.90.

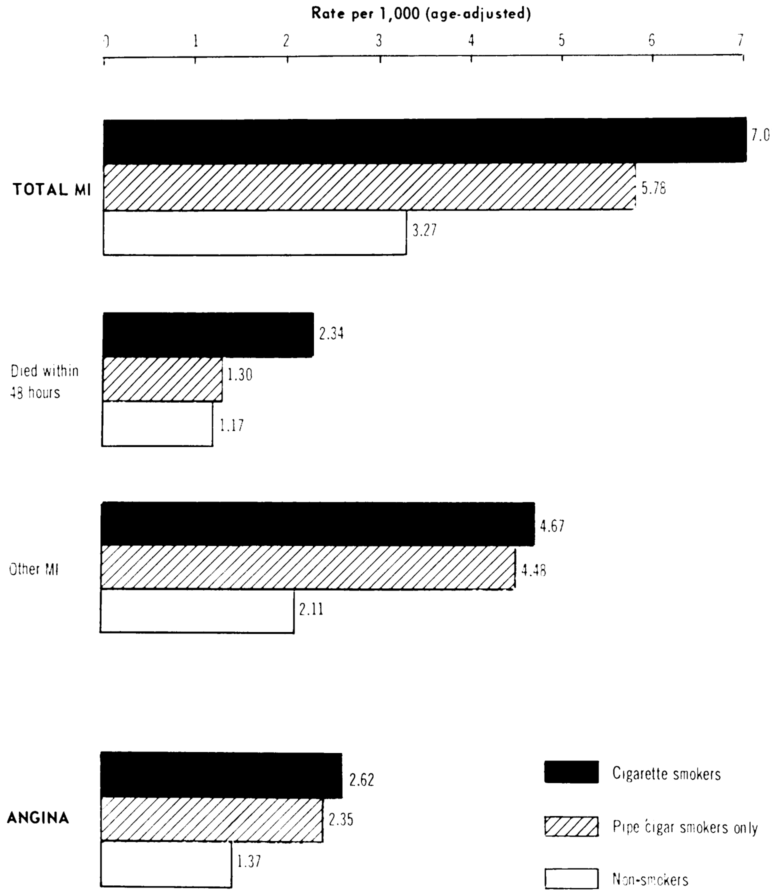


Figure 3—Average annual incidence of first MI and angina among men in relation to smoking habits

port of the Surgeon General's Advisory Committee,[14] in Epstein's review,[4] and updated in a more recent Public Health Service review.[15] The differential in incidence of MI between cigarette smokers and nonsmokers is of the same order of magnitude as the mortality differentials for coronary disease cited by these sources. Similarly, relative excess risk among persons aged 45-54 as compared with older persons and among heavy smokers as compared with others, and the fall in risk among men who stop smoking cigarettes have been documented in these reports from a number of studies. The HIP findings with respect to smoking and incidence of MI among women are parallel to those in men.

Data from other studies in relation to pipe/cigar smoking and CHD are more fragmentary and the findings are less uniform than those concerned with cigarettes. The 1964 report to the Surgeon General[14] concluded that "The association of coronary disease with the use of tobacco in other forms has not been striking," and the more recent Public Health Service report[15] states that "Epidemiological evidence indicates that there is little risk of coronary heart disease associated with cigar and/or pipe smoking." The earlier report cites an over-all mortality ratio of 1.20

($p<0.05$) for men smoking five or more cigars daily (computed by combining the data from four studies). The more recent report provides no updated data on pipe/cigar smoking.

Relatively higher CHD death rates among cigar smokers and relatively lower CHD death rates among both pipe smokers and men who never smoked regularly have been reported by Hammond.[16] The current findings from the HIP study do not distinguish between pipe and cigar smokers, but they do support the presence of an association between CHD in men and forms of tobacco smoking other than cigarettes. In these data this association is noted for nonfatal MIs and angina, but not for the rapidly fatal MIs.

Reports in the literature on the relationship of smoking and angina pectoris have been inconsistent. The 1964 report to the Surgeon General[14] stated:

> "Angina pectoris is less closely related to cigarette smoking than myocardial infarction and sudden death. In the combined Albany-Framingham experience, angina pectoris showed no over-all relationship with smoking, and the association has not been strong in other studies."

The 1967 report[15] again took note of inconsistent findings from a number of studies, including a positive association noted from the HIP preliminary incidence data and in unpublished data from Framingham considered separately.

The difficulties in interpreting data on angina which are imposed by differing diagnostic criteria and methodologies have already been noted in connection with incidence data by age and sex. Such difficulties are compounded when rates are based on low frequencies. Combined experience of men in the Albany and Framingham studies has twice been reported on the subject of cigarette smoking and coronary heart disease.[17,18] The second report covered the experience of men originally free of CHD and followed for ten years (Framingham) and eight years (Albany). The authors point out that "Individuals suffering from both angina pectoris and myocardial infarction are listed under the latter category." Average annual incidence rates of angina, as defined, for men aged 40-49 at entry and based on eight years of experience in both study settings were given as 1.8 (per 1,000 per year) for noncigarette smokers and 2.1 for cigarette smokers. The authors drew a conclusion of "no apparent relationship . . . between cigarette habit and angina pectoris when it is the sole manifestation of CHD" which has been cited in both Public Health Service reports[13,14] and, more recently, by Seltzer[19] in an article directed toward evaluation of the effect of smoking on coronary heart disease.

The incidence rates cited by Doyle, et al.,[18] for angina from the Framingham data alone showed an excess risk for cigarette smokers (average annual incidence of 2.7) in comparison with noncigarette smokers (1.4) among men 40-49 years of age at start of observation. These rates were based on very low frequencies of men with angina (11 cigarette smokers and 3 noncigarette smokers), but in a more recent report from Framingham covering 12 years of experience Kannel[20] has stated: "Risk of every manifestation of CHD . . . was sharply increased in heavy cigarette smokers." In this report a morbidity ratio (observed to expected cases) for angina pectoris of 155 is given for men who smoke more than one pack of cigarettes daily in contrast with 81 for nonsmokers. The HIP age-adjusted incidence rate for angina among smokers of one or more packs of cigarettes per day is 2.6 per 1,000 and that for nonsmokers is 1.4. Accordingly, both the more recently reported Framingham experience and the HIP findings suggest that the risk of these heavy smokers for angina is almost twice that of the men who do not smoke.

V. PHYSICAL ACTIVITY

The relationship between usual level of physical activity and incidence of the manifestations of CHD of concern in this report has been examined from several standpoints. The discussion is restricted to males, since difficulties in collecting meaningful information on physical activities in which housework plays an important role precluded use of this variable for females.

Based on responses to questions related to amount of time spent walking and sitting on the job, means of getting to and from work, frequency of lifting and carrying heavy things and total hours worked, a four-point scale from "least active" to "most active" was constructed for physical activities connected with the job. A similar scale for physical activities off the job is based on the answers to a group of questions on customary habits with respect to the frequency and nature of sports engaged in, the frequency of taking walks in good weather, of working around the house or apartment, and of gardening in the spring or summer. Finally, the men are classified by their over-all level of physical activity by combining the job-connected and off-job physical activity categories as shown in Figure 4. The "least active" men, represented by the white area in the figure, are (a) those who fell into the lowest activity class both on and off the job, plus (b) those who were lowest from one of these classifications and in the next adjacent class from the other. All other men classified by over-all physical activity level are referred to as "more active" —these are subdivided into the "most active" (men in the highest activity class either on or off the job) and the remaining intermediate or moderately active group. (See Appendix D for details on construction of the physical activity scales and Appendix C for discussion of the limitations of the data.)

Myocardial Infarction

A marked association exists between the incidence of a first MI and the overall level of physical activity (Table R2). Men who are least active have twice the risk of suffering a first MI found among men who are more active (Figure 5). The change in risk is entirely between the least active and the moderately active categories; men classified as most active do not appear to have any advantage over the moderately active men.

Almost half of the physically inactive men (45 per cent) who have a first MI die soon after the attack, in contrast with a case fatality rate of 22 per cent among the more active men. The extent of the elevation in risk of incurring a rapidly fatal first MI that is as-

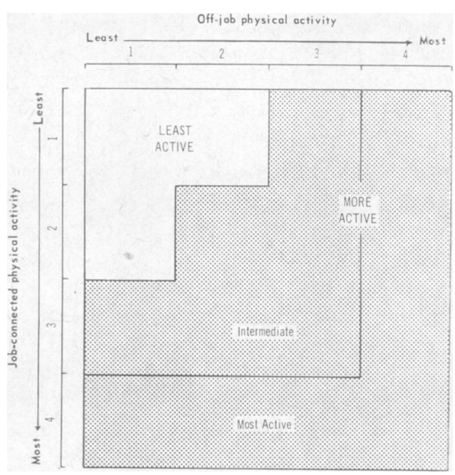


Figure 4—Definition of over-all physical activity classes in relation to job-connected and off-job physical activity

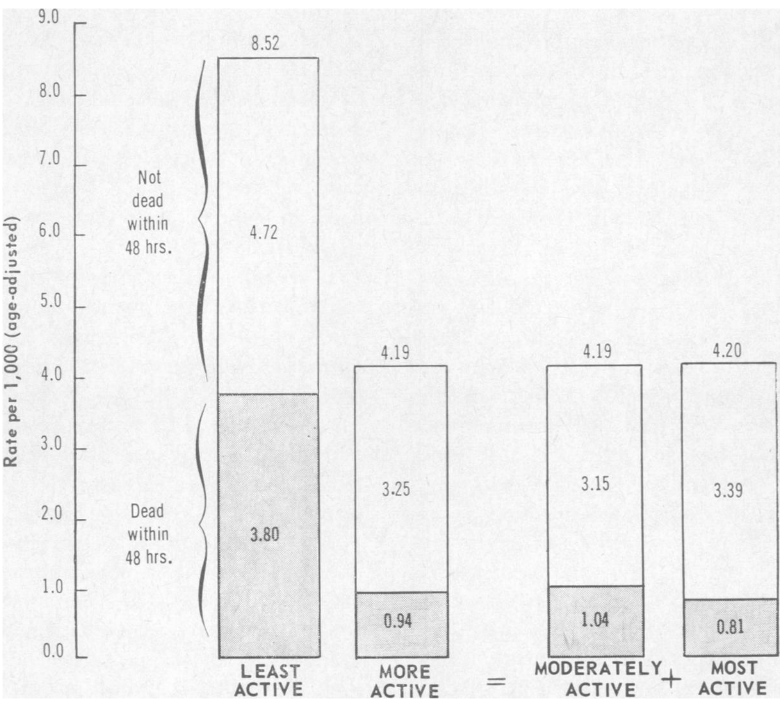
sociated with physical inactivity is seen more dramatically when incidence rates of first MIs fatal within 48 hours per 1,000 men at risk in the population are examined. The rate among the physically inactive men is 3.8 as compared with a rate only one-fourth as large (0.9) among the more active men. The least active men also have a relatively high incidence rate for a nonfatal attack, but the rates are much closer (4.7 among the least active and 3.3 among the more active).

The specific combination of job-connected and off-job categories of physical activity illustrated in Figure 4 is the primary classification of over-all physical activity in the current report. However, to determine whether the relationship between physical inactivity and MI rate is altered by a change in the combination of categories, the following alternative over-all physical activity scale was structured:

	Physical activity gradient	
	Job-connected class	Off-job class
Least active	1 or 2	1 or 2
First intermediate	3 or 4	1 or 2
Second intermediate	1 or 2	3 or 4
Most active	3 or 4	3 or 4

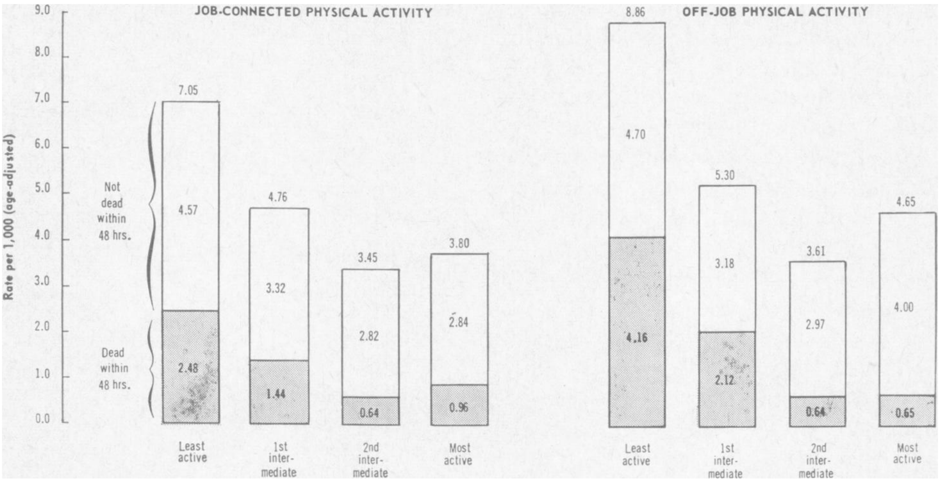
Relationships very similar to those noted above are seen among the incidence rates for men classified in this alternative way (Table R2). There is a

Figure 5—Average annual incidence of first MI among men in relation to over-all physical activity class (age-adjusted rates per 1,000)



NOTE: Differences between the rates among least active and more active men for total MI, rapidly fatal, and other MIs are statistically significant at the 0.99 confidence level.

Figure 6—Average annual incidence of first MI among men in relation to job-connected and off-job physical activity class (age-adjusted rates per 1,000)



NOTE: Differences between the rates among men in the *least active* and *first intermediate* classes for total MIs and rapidly fatal MIs are statistically significant at the 0.99 confidence level, for other MIs at the 0.95 confidence level. Differences between rates among men in the *first* and *second* intermediate classes for total MIs are statistically significant at the 0.95 confidence level, for rapidly fatal MIs at the 0.99 confidence level.

NOTE: Differences between the rates among men in the *least active* and *first intermediate* classes, and between those in the *first* and *second* intermediate classes are statistically significant at the 0.99 confidence level for total and for rapidly fatal MIs. For other MIs only the difference between the least active and first intermediate class is statistically significant (confidence level 0.95).

sharp difference between the rate of a first MI among least active men and that for more active men. The elevated risk is again heavily concentrated in the rapidly fatal first MIs. Among these the rates from the alternative classification do show a gradient of successive decreases as physical activities increase.

Separate consideration of job-connected and off-job physical activities emphasizes the disadvantage of the least active men (Figure 6). Men who are physically inactive either on or off the job have considerably higher incidence rates than the men who are only moderately more active. An additional modest decrease in the incidence rate occurs in the next higher activity category, but the men who are most active have no advantage over the two intermediate groups of moderately active men. The disadvantage among sedentary men, whether so classified because of job-connected or off-job activities, is concentrated almost entirely in the risk of suffering a rapidly fatal first MI. The differential between the early mortality rate for least active and more active men is greater in the off-job classification, but this may only reflect differences in the questions asked and the conventions used in constructing these two indexes of physical activity.

In all of the measures of physical activity least active men both under 55 years of age and those aged 55-64 have appreciably higher rates for first MI than more active men (Table R2 and Figure 7). Also, the differential between least and more active men in risk of incurring a rapidly fatal first MI is of major proportions in both age groups.

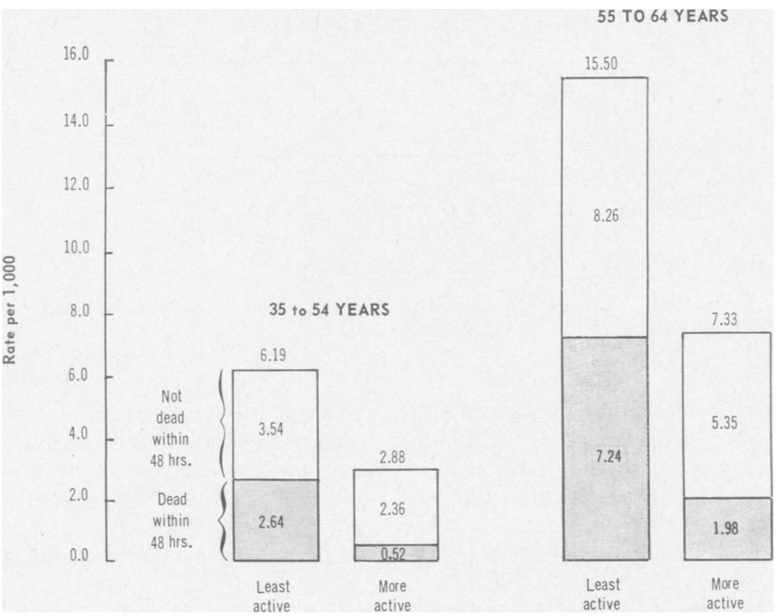
The possible role of a variety of medical and personal characteristics in explaining the elevated risk among least active men has been examined. When the first MI incidence rates exclude men with a reported limitation of physical activities prior to the date of MI or men with a prior manifestation of CHD (usually angina pectoris), there is a reduction in the margin between the least active and more active men, but the differential is still substantial (Figure 8).

The effect of taking hypertension into account cannot be assessed in a similar direct way because of the lack of blood pressure information for the population exposed to risk. However, to estimate the possible influence of this factor, all cases of first MI with known prior CHD or with prior elevated blood pressure were removed from the numerators of the rates. The number of nonhypertensive men at risk was computed on the assumption that the incidence of first MI among hypertensives is twice that among nonhypertensives.* The age-adjusted rates derived from these computations show significant differences between the least active and the other men in their risk of a first MI (Figure 8).

In the search for intervening variables that might be influencing the association between physical inactivity and increased risk for an initial MI, three demographic variables—education, religion, and color—have also been examined. The least active men in the population at risk differ demographically from the more active, principally in educational and religious composition. Thus 52 per cent of the least active men have attended college, compared with 34 per cent of those more active; of the white men at risk, 55 per cent of the least active are Jewish, compared with 36 per cent of the more active. The comparisons in Figure 9a indicate that these variables (to be discussed in section VII) are not serious confounding fac-

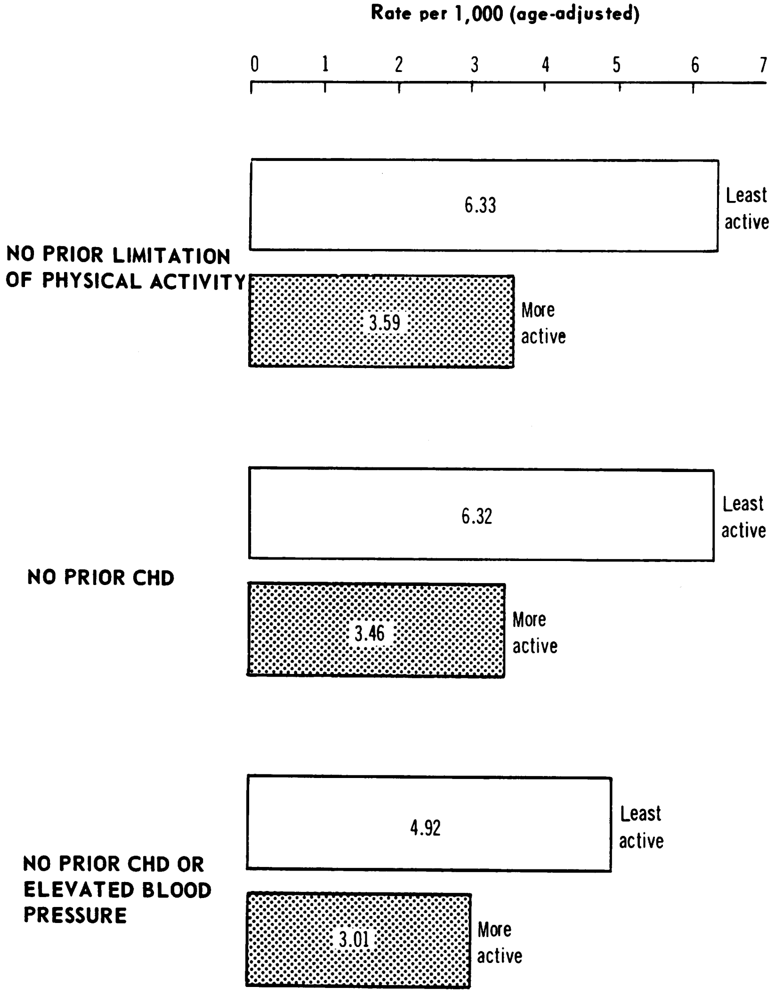
* The computation results in an estimate of 10.8 per cent prevalence of hypertension for all men at risk in the HIP study population, which compares well with the National Health Examination Survey figure of 12.0 per cent for white males who are usually working.[21]

Figure 7—Average annual incidence of first MI among men in relation to over-all physical activity class and age (rates per 1,000)



Note: In both age groups differences between the rates among men in the least and more active classes are statistically significant at the 0.99 confidence level for total MI and for rapidly fatal MIs, and at the 0.95 confidence level for other MIs.

Figure 8—Average annual incidence of first MI in relation to over-all physical activity: three restricted groups of men (age-adjusted rates per 1,000)



NOTE: Differences between the rates among men in the least and more active classes are all statistically significant at the 0.99 confidence level.

tors. Within each of the educational and religion-color subgroups the MI incidence rate for the least active men is substantially higher than that for the more active men.

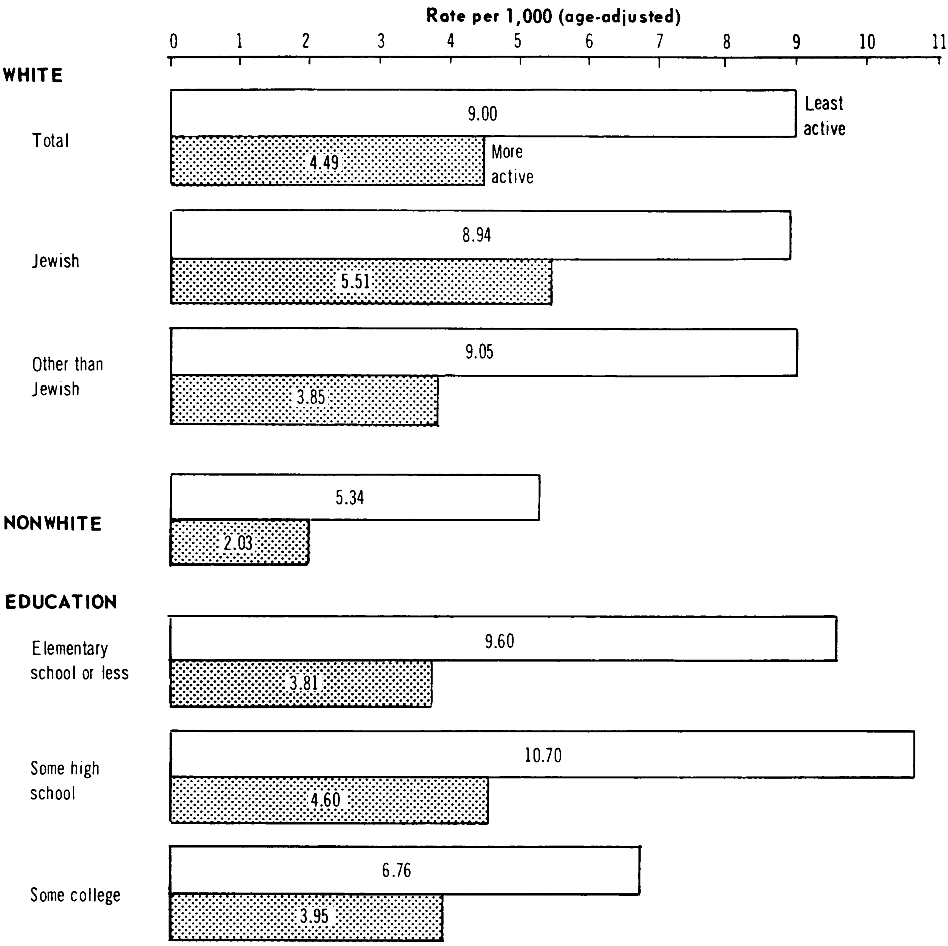
A similar comparison of incidence of first MI between the least and more active men within specified categories of body weight (to be discussed in section VI) is shown in Figure 9b. The excess risk of the inactive men is apparent among those of both high and low relative weight, and among those with a relatively high weight gain during adult life as well as those with a lower weight gain. It is clear that the differences in relation to physical activity are not simply reflections of differences in risk in relation to categories of body weight.

Finally, differences in smoking practices are not sufficiently important to affect the margin between the first MI rates for least active and more active men (Table R9 and Figure 10). Physically inactive men show a higher incidence of first MI than men who are more active, both among cigarette smokers and those who do not smoke cigarettes. The smokers exhibit an incidence of first infarction which is almost twice that of nonsmokers. Little difference in incidence of initial MI is found between the least active nonsmokers (6.3) and the relatively more active cigarette smokers (5.8). The highest incidence (10.9) is experienced by inactive smokers, and the lowest (3.0) by the relatively more active nonsmokers, with more than a threefold difference between these two groups.

Angina and Possible MI

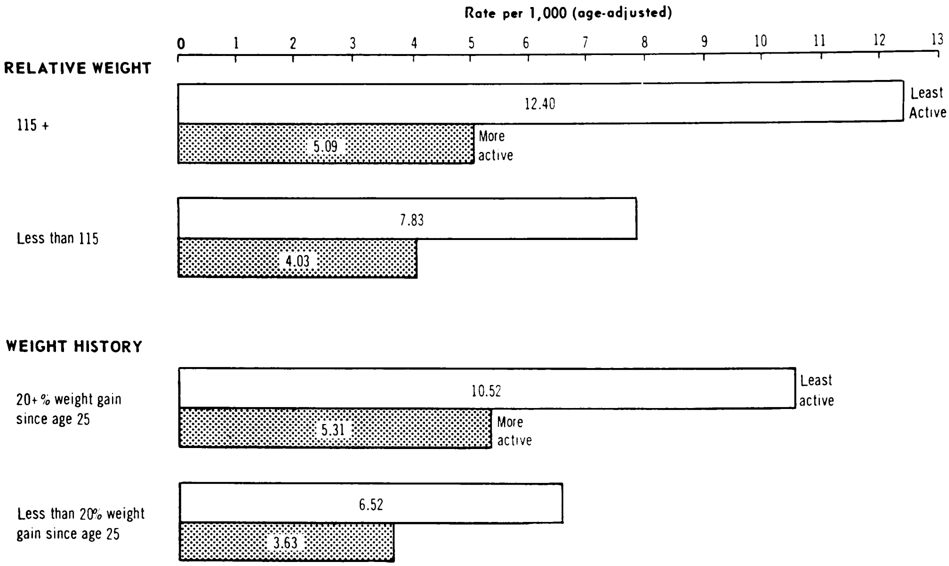
No association is found between the general level of physical activity—over-

Figure 9a—Average annual incidence of first MI in relation to over-all physical activity and selected demographic characteristics (males)



NOTE: Differences between the rates among men in the least and more active classes are statistically significant at the 0.99 confidence level in all categories shown except nonwhite, where the confidence level is 0.90.

Figure 9b—Average annual incidence of first MI in relation to over-all physical activity and categories of body weight (males)



Note: Differences between the rates among men in the least and more active classes are statistically significant at the 0.99 confidence level in all categories shown except the last (less than 20% weight gain), where the confidence level is 0.95.

all, job-connected, or off-job—and the incidence of angina (Table R2). This holds both for men under 55 and those 55-64 years of age. Preliminary data from the current study suggested that the relative risk for angina might be highest among men who were most active.[1] However, the more complete series reported here shows almost identical rates among the most active and the less active men.

Physically inactive men have a slightly higher risk of incurring a possible MI than more active men (Table R2). The elevation in risk (about 50 per cent) is of the same order of magnitude as that shown by the least active men for a first MI which is not rapidly fatal. However, in the case of possible MI the differential in risk is completely eliminated when the rates are restricted to men with no history of prior CHD or to men with no prior limitation of physical activity.

Occupation and Physical Activity

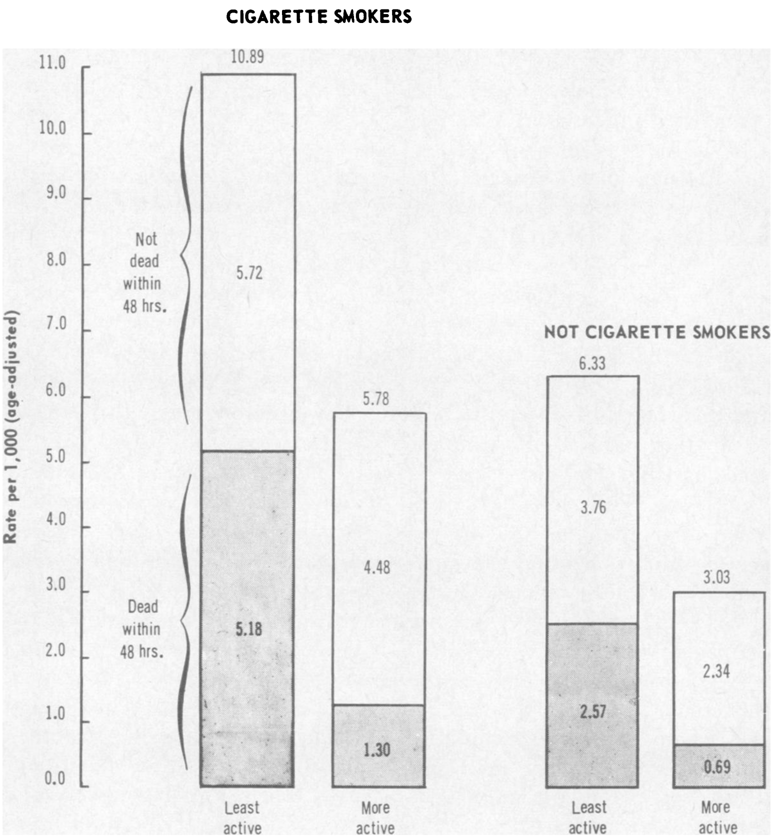
Occupation has in the past been used both as a socioeconomic measure and as an indicator of job-connected physical activity. The value of occupational information for the latter purpose is directly related to its specificity, and the broad categories into which it was necessary to group the data in this study impose serious restrictions on their utility as an alternative to the classification of job-connected physical activity previously discussed. Nevertheless, the occupational rates (Tables R5 and R6) do provide general support for the findings already presented about the relationship between physical activity and CHD incidence. Age-adjusted rates for first MI are very similar for white collar and blue collar workers, but when smoking habits are also taken into account the difference between the rates (6.2 white collar vs. 4.8 blue collar) is statistically significant ($p<0.01$). However, when adjustment is made for age and over-all physical activity the difference between these two categories (4.2 white collar and 3.7 blue collar) virtually disappears. White collar and blue collar workers have almost identical incidence rates of angina and of possible MI. The differences between these categories of workers with respect to these two CHD manifestations remain very small when adjustment is made for smoking habits or over-all physical activity in addition to age.

When the white collar and blue collar workers are classified further by broad occupational category, the range in MI rates is relatively small. Men in clerical and sales occupations show the highest incidence of MI (6.5), while service workers and laborers have the lowest rate (4.4). It is of interest that clerical and sales workers also have relatively high rates of angina and possible MI.

Comment

There is a strong indication in the data here presented that the risk of a first

Figure 10—Average annual incidence of first MI among men in relation to over-all physical activity class and smoking habits (age-adjusted rates per 1,000)



NOTE: Both for cigarette smokers and noncigarette smokers differences between rates among the least and more active men are statistically significant for total MI and rapidly fatal MIs at the 0.99 confidence level. For other MIs the difference is statistically significant only for the nonsmokers (confidence level 0.95).

MI is substantially greater among men classified as sedentary on the basis of their levels of physical activity on and off the job than among men only moderately more active. This relationship remains when smoking practices, educational attainment, categories of body weight, and ethnic and religious backgrounds are taken into account, and when the comparisons are restricted to men either with no history of prior coronary heart disease or no prior limitation of physical activity. Furthermore, the association between physical inactivity and elevated incidence of a first MI is found both among men under age 55 and among those aged 55-64.

Sedentary men with no prior MI appear to be at particularly high risk for a rapidly fatal infarction—their incidence rate for such MIs is about four times that among the more active men in the current study. The risk of a nonfatal first MI is only moderately greater among the inactive men. There is no association between the incidence rate of angina or possible MI and level of physical activity. In general, these relationships are also observed when men are classified on the basis of either their job-connected activities or their off-job activities alone.

A substantial body of literature has appeared on the subject of coronary heart disease and physical activity.[4,22,23] In 1953, Morris and his associates demonstrated that London bus drivers experienced a higher age-specific incidence of MI than conductors, while the incidence of angina was lower among the bus drivers.[24] Questions remained about these relationships because of the possible differences between the two occupational groups in characteristics other than physical activity at work. Morris found, for example, that the bus drivers were heavier in weight than the conductors before starting on their jobs.[25]

Subsequently, a number of studies have sought an association between specific occupational classification (as an index of physical labor) and various parameters of coronary heart disease. Breslow and Buell[26] used occupational mortality data for California to classify men by level of physical activity and found that sedentary workers had an increased mortality rate from arteriosclerotic heart disease. Taylor and his co-workers, utilizing mortality data for railway workers,[27] and Kahn, with mortality data for postal clerks and mail carriers in Washington, D. C.,[28] reported similar relationships. Studies in North Dakota,[29] Evans County, Georgia,[30] and communal settlements in Israel[31] have produced findings suggestive of an association between physical inactivity and coronary heart disease prevalence.

On the other hand, Chapman[32] and Stamler[33] and their associates reported no significant relationship between physical activity and coronary heart disease. Also, Spain and Bradess[34] reported no association between the prevalence of coronary atherosclerosis at autopsy and the occupational status of men dying of noncardiac causes. But an autopsy study by Morris and Crawford[35] found that physical activity was less related to coronary atherosclerosis than to myocardial scars, suggesting that exercise might operate to encourage a better collateral circulation rather than protect against atherosclerosis as such. Animal experimentation by Eckstein[36] has demonstrated that dogs with coronary arterial partial occlusions develop a more effective collateral circulation when forced to exercise than when kept at rest.

The observations in the HIP study add further support to the hypothesis that a significant elevation in the risk of a first MI is associated with physical inactivity. As with the other investigations which have been cited, several circumstances impose restrictions on the interpretation of the differentials found.

Perhaps the most important derive from the methodology of the study. As discussed previously (section I) and in detail in Appendix C, physical activity information for the population at risk was obtained from the responses to a mail survey; for the men with a first MI the data were obtained through an interview after the attack with the patients or their next of kin. From the fragmentary evidence available it would appear that even though the interview of men who had recovered from an MI attempted to reconstruct job-connected and off-job activities prior to the attack, there could have been a tendency on the part of these men to understate their level of activities before the illness. The important question is whether such bias could be large enough to account for the differentials found; from the available information no effect of such magnitude is suggested. In this connnection it is of interest that the Framingham study,[20] where the physical activity index was based upon direct interview with the men prior to the onset of illness, reported an excess risk of fatal attacks of CHD among sedentary men.

Question may also be raised about the role of intervening factors other than those available in the HIP data in explaining the differentials found. The study design did not provide for measurements of serum cholesterol concentration in the HIP population at risk, nor in men who died before a baseline examination could be scheduled. There is therefore no information on the distribution of serum cholesterol among men in the physical activity categories which have been discussed. A few studies have related serum cholesterol concentrations to physical activity levels in population samples. Chapman[37] found somewhat higher mean cholesterol levels for white men who evaluated their physical activity at home as "not very active" than for his three other physical activity classes. Taylor[38] reported no significant differences in serum cholesterol concentrations between occupations in the railroad industry. Montoye[39] reported significantly higher serum cholesterol concentration in a group of business executives than in the general Tecumseh, Michigan, population, but he noted that when serum cholesterol level was compared to the level of physical activity within each group there was "surprisingly little" correlation. In the Framingham study population two groups of men with "low" (177 mg/100 ml, average) and high (311 mg/100 ml, average) cholesterol levels showed no differences in physical activity expressed as an index of the usual 24-hour activity of the subjects.[40]

Fox and Skinner[41] have reviewed the available evidence on the impact of physical activity upon serum cholesterol concentration, and conclude that there is little to suggest that physical activity reduces the serum cholesterol levels except when weight loss occurs. It has been reported that one-half-year programs of intensive physical exertion induce no significant changes in the serum cholesterol levels of middle-aged men.[42]

Other variables, such as psychological factors, which might influence the excess risk associated with physical inactivity have not been examined in this study. Accordingly, one cannot dismiss the possibility that some unidentified factor both predisposes men to physical inactivity and increases their risk for first MI.

Many questions arise from the HIP findings for which the current data cannot provide answers. There may well be important differences between different types of physical activities: a sustained, endurance type of effort in contrast to briefer and more intense exertion; walking or climbing in contrast with heavy lifting or straining; or sudden severe exertion in the habitually inactive or untrained man in contrast with similar effort on the part of men in better physical condition. It is clearly desirable to examine these issues with more refined investigative tools.

In this study the level of customary physical activity was classified as of the time period immediately preceding the initial myocardial infarction. No historical information on changes in patterns of physical activity throughout adult life was sought. One cannot judge from the data presented whether the relatively inactive adult male who moderately increases his customary level of physical activity thereby acquires the advantage of the lower risk of MI, and more particularly the lower mortality from first infarction, shown by the other men. Nor is it possible to predict how soon such a postulated advantage might appear. The importance of obtaining answers to these questions is evident. Favorable answers would project the possibility that moderate increases in the physical activities of the least active members of an adult male population without prior myocardial infarction might significantly reduce the incidence of, and the morbidity and mortality from, this manifestation.

VI. CATEGORIES OF BODY WEIGHT

Two classifications dealing with body weight were defined for the development of incidence data, and detailed rates are presented for males in Tables R7 and R8 and for females in Table R11. A crude measure of "overweight" is considered as a body weight 15 per cent or more above the average weight for individuals of the same age, sex, and height.* Another measure was constructed on the basis of the weight history during adult life (since age 25). Questioning was directed toward establishing maximum and minimum weights during adult life, together with the ages corresponding to these weights. All persons reporting gains in weight since age 25 were then classified by expressing the weight gain as a percentage of the lowest adult weight. Persons who reported their minimum weight at an age which was the same or older than that reported for maximum weight could not be classified as to weight gain during adult life. Such individuals were tabulated separately, and the group is a conglomerate one which includes both those who reported no weight gain since age 25 and persons who did gain weight since that age and subsequently reduced their weight. Although no data are available on body build or skinfold measurements, the crossing of weight history with relative weight permits separate examination of a group of persons with high relative weight who sustained a weight gain of less than 10 per cent since age 25; it seems reasonable to infer that this group contains a smaller proportion of obese individuals than the group of similar high relative weight who sustained greater weight gains over the course of adult life.

Table 4 presents a summary of age-adjusted incidence rates of MI, angina, and possible MI in relation to the two described weight classifications. Among

* Average weight tables from Build and Blood Pressure Study (Society of Actuaries, 1959) were used to compute relative weight.

men the risk of a first MI is elevated for those in an excess weight category, whether based on the relative weight or the weight history. The excess risk is concentrated in the first MIs which are not rapidly fatal: here, men who are 15 per cent or more above average weight have about 1.5 times the incidence rate of those with relative weight less than 95 (4.8 and 3.0, respectively); those with a 20 per cent or greater increase in weight since age 25 have twice the rate shown by men whose weight increased less than 10 per cent (4.8 and 2.4, respectively). An excess risk of the same order of relative magnitude is demonstrated both for angina and possible MI by the highest weight gain group in comparison with the lowest weight gain group. Incidence of angina and possible MI is also higher among the men with relative weight of 115 or more in comparison with those of lower relative weight, but the difference between the highest and lowest relative weight classes suggests statistical significance only in the case of angina.

It is of interest that the weight history identifies men at relatively high risk for MI, angina, and possible MI

Table 4—Average annual incidence of specified manifestations of CHD in men and women, by relative weight and weight history—age-adjusted rates per 1,000

Weight category; sex	Myocardial infarction Total	Died within 48 hrs	Other	Angina	Possible MI
Males					
Relative weight					
115+	6.25)†	1.46	4.79)**	2.74)†	1.77
95-114	4.76	1.45	3.31	1.92	1.09
Under 95	4.73)	1.68	3.04)	1.81)	1.15
Per cent increase in weight since age 25					
20+ %	6.44)**	1.60	4.84)**	2.92)**	1.77)**
10-19 %	4.55	1.44	3.11	2.40	1.48
Less than 10 %	3.32)	0.90	2.42)	1.37)	0.69)
Females					
Relative weight					
115+	1.17	0.37	0.80	1.41)**	1.17)**
95-114	1.19	0.38	0.81	1.30	0.72
Under 95	0.73	0.23	0.50	0.55)	0.40)
Per cent increase in weight since age 25					
20+ %	1.14	0.26	0.88)*	1.46)**	0.98
10-19	0.69	0.13	0.56	1.34	0.73
Less than 10 %	0.83	0.43	0.39)	0.18)	0.60

Note: Confidence levels in the statistical significance of differences between rates for end classes are designated ** for 0.99, * for 0.95, and † for 0.90. "Relative weight" is the ratio of the individual's weight to the mean weight for the appropriate age-sex-height group from the average weight tables of the 1959 Build and Blood Pressure Study, Society of Actuaries.

Figure 11—Average annual incidence of first MI among men in relation to relative weight and weight history (age-adjusted rates per 1,000)

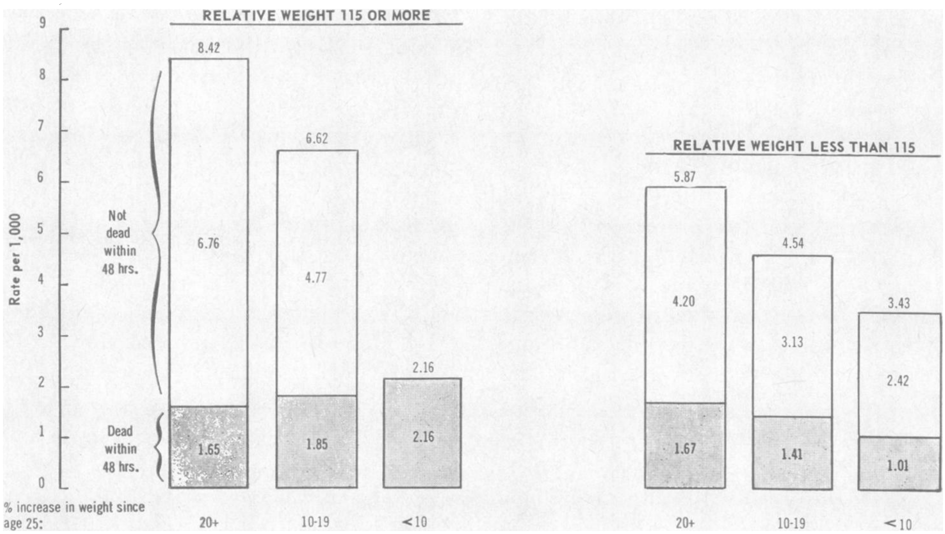


Table 5—Average annual incidence of specified manifestations of CHD in men of specified relative weight by weight history—age-adjusted rates per 1,000

Percentage increase in weight since age 25	Myocardial infarction: Total, Relative weight 115+	Myocardial infarction: Total, Relative weight <115	Myocardial infarction: Not dead in 48 hrs, Relative weight 115+	Myocardial infarction: Not dead in 48 hrs, Relative weight <115	Angina, Relative weight 115+	Angina, Relative weight <115	Possible MI, Relative weight 115+	Possible MI, Relative weight <115
20% or more	8.42	5.87	6.76	4.20	3.34	2.75	2.18	1.67
10 - 19%	6.62	4.54	(4.77)#	3.13	(4.40)#	2.37	(2.27)#	1.41
Less than 10%	(2.16)#	3.43	(2.16)#	2.42	(1.06)#	1.41	(1.08)#	(0.68)#

Numerator frequency less than 10.

both among those who are "overweight" (relative weight 115 or greater) and others (relative weight less than 115). In both these relative weight categories the incidence of MI (total and not rapidly fatal) increases with increasing percentage weight gain since age 25 (Figure 11 and Table 5). Men with weight gain of 10 per cent or more show higher incidence rates of both angina and possible MI than those with a weight gain of less than 10 per cent. For all three manifestations of CHD a relative weight of 115 or more is associated with higher incidence only if there has been an increase in weight during adult life of 10 per cent or more.

The relationships between incidence of

CHD manifestations in men and the indicators of excess weight remain essentially unchanged when adjustment is made in the incidence rates for smoking habits and physical activity as well as age (Table R8). The rates for the conglomerate group described above (men reporting their minimum adult weight at either an older age or at the same age as their maximum weight) which are shown in the detailed tables usually occupy an intermediate position among the rates arranged in relation to the magnitude of the percentage weight increase.

Among women (Table 4) both the highest relative weight category and those with the greatest percentage increase in weight during adult life show an increased risk for angina in comparison with the lowest corresponding weight category ($p<0.01$). A relatively increased risk for first MI which is not rapidly fatal is also shown by those women who have experienced a weight increase of 20 per cent or more.

No statistically significant association is shown in these data between the described indicators of excess weight (high relative weight and high percentage weight increase during adult life) and the risk of rapidly fatal myocardial infarction, either in men or in women. Among men, however, there is a gradient in the rates for such MIs in relation to increasing percentage weight gain since age 25.

Comment

The difficulties, both conceptual and practical, which arise in connection with efforts to define the role of obesity in epidemiological studies of coronary disease have been noted by many investigators. Epstein[4] has pointed to the paradoxical finding of an association between increased risk of CHD only with *gross* obesity in the Framingham study,[10] in spite of the generally elevated morbidity and mortality among "overweight" compared with "normal" persons reported from insurance data.[43] He has cautioned in his review:

> "In a disorder caused by multiple disturbances, the confounding effect of variables is so complex and the analysis of their separate contributions so dependent on large numbers of cases that it would be well to keep an open mind on the relationship between coronary disease and obesity." (Op. cit., p. 753.)

The data here presented on incidence of CHD manifestations in relation to defined weight categorizations must also be interpreted with caution. No measurements of either serum cholesterol or blood pressure are available for the population at risk for incidence of new manifestations of CHD in the HIP study. Since correlations have been reported between obesity and both of these variables,[10,44] it is not possible to estimate any "independent" contribution of excess weight from the current data. Neither are there somatotype or skinfold data to distinguish the obese from the "overweight," a distinction the importance of which has been well documented by Seltzer.[45] There is, nevertheless, little question that higher incidence rates of both myocardial infarction and angina were associated with the described indicators of excess body weight in the HIP population of men at risk. Weight increase during adult life, expressed as a percentage gain over the minimum weight since age 25, was for this population a more sensitive indicator of excess risk than a high relative weight; unless there was an increase of 10 per cent or more in weight over the adult life span, no increased risk was associated with high relative weight alone. But among men who were 15 or more per cent above average weight for their age and height, the risk of first MI for those experiencing a 20 per cent or greater gain in weight was almost four times that of those who had gained less than 10 per cent (8.4 and 2.2, respectively).

In this connection it is of some importance that almost one-third of both men and women in the HIP population, for whom a weight history was obtained, were classified as having experienced a gain in weight during adult life which was 20 per cent or more of the lowest weight noted since the age of 25. Only 16 per cent of the men and 14 per cent of the women at risk were classified as exhibiting a "relative weight" which was 15 per cent or more above average. Similarly, only 10 per cent of the Framingham men and women were classified as "Framingham relative weight" of 120 or more.[10]

In contrast with the experience reported from Framingham, where it was concluded that overweight was strongly related to risk of sudden death but not to that of other myocardial infarction,[7] the excess risk associated with indicators of overweight among the HIP men was more pronounced with respect to MIs which were not rapidly fatal.

VII. DEMOGRAPHIC AND SOCIAL CHARACTERISTICS

Color, Religion, Place of Birth

Detailed rates for whites and nonwhites, for the three major religious categories, and for persons classified by place of birth appear in Tables R3 and R4 (males) and R10 (females). The age-adjusted rates summarized in Figure 12 and Table 6 show an incidence of MI among white men (5.4) which is twice that of the nonwhites (2.7), and an incidence of angina one and one-half times that of the nonwhites (2.1 and 1.4, respectively). The excess incidence of MIs is concentrated in those which are not fatal within 48 hours, where the rate for whites (3.7) is more than two and one-half times that for nonwhites (1.4). No difference is apparent in incidence of possible MI among men in relation to color. Although the rates among white women for MI, angina, and possible MI are somewhat higher than those for nonwhites, the frequencies involved are low and the rates are subject to very large sampling variability.

CHD incidence by religion is examined separately in the white population (Table 6 and Figure 12) because of the large weighting of the Protestants with nonwhites. Jewish men experience a higher incidence of MI, angina, and possible MI than Catholic or Protestant men. Although the incidence of rapidly fatal MIs is virtually the same among the white men in the three religious groups, the Jewish men have an incidence of other MIs (5.0) which is almost twice that shown by Catholics (2.8) and one and one-half times that shown by the Protestants (3.4). A pattern of incidence similar to that among the men is suggested by the rates for white women classified by religion; for example, among the Jewish women the rate for MIs which are not rapidly fatal is more than one and one-half times that found for the Catholics.

No important differences in CHD incidence are apparent between native-born men or women and those born in Europe (Table 7). When the rates for Eastern, Western, and Southern Europe are examined separately, it is seen that the somewhat higher rates for the European-born in comparison with those born in continental United States reflect the higher incidence among those born in Eastern Europe, a population heavily weighted with Jews. To take both religion and place of birth into account, a comparison has been limited to the two largest religious groups in the study population—Jews and Catholics—in order to avoid the influence of the nonwhite component among native-born

Figure 12—Average annual incidence of first MI and angina among men in relation to color and religion (age-adjusted rates per 1,000)

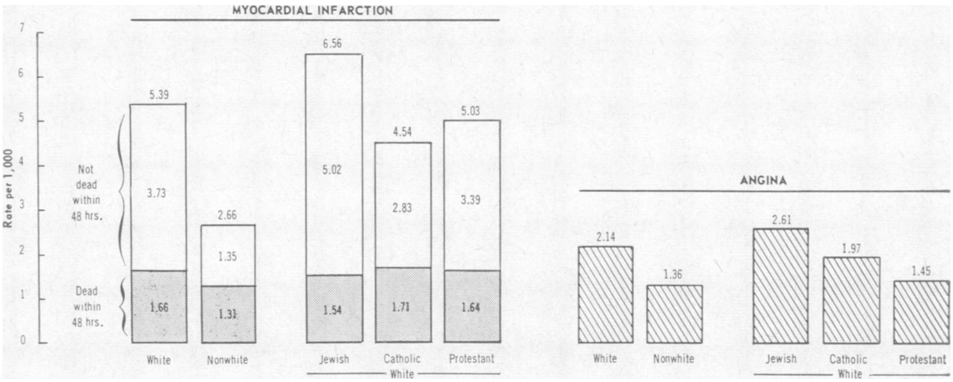


Table 6—Average annual incidence of specified manifestations of CHD in men and women, by color and religion—age-adjusted rates per 1,000

Color; religion; sex	Myocardial infarction: Total	Myocardial infarction: Died within 48 hrs	Myocardial infarction: Other	Angina	Possible MI
Males					
White	5.39)**	1.66	3.73)**	2.14)**	1.22
Nonwhite	2.66)	1.31	1.35)	1.36)	1.19
White only					
Jewish	6.56)**	1.54	5.02)**	2.61)†	1.47
Catholic	4.54)	1.71	2.83)	1.97)	1.13
Protestant	5.03	1.64	3.39	1.45	(0.55)#
Females					
White	1.01	0.35	0.66	0.95	0.66
Nonwhite	(0.61)#	(0.09)#	(0.52)#	(0.85)#	(0.48)#
White only					
Jewish	1.05	0.20	0.85)†	1.19	0.53
Catholic	0.92	0.39	0.53)	0.86	0.86
Protestant	0.93	(0.65)#	(0.28)#	(0.38)#	(0.48)#

NOTE: Confidence levels in the statistical significance of differences between rates are designated as ** for 0.99, * for 0.95, and † for 0.90.

Numerator frequency less than 10.

Table 7—Average annual incidence of specified manifestations of CHD in men and women, by place of birth—age-adjusted rates per 1,000

Place of birth; sex	Myocardial infarction: Total	Myocardial infarction: Died within 48 hrs	Myocardial infarction: Other	Angina	Possible MI
Males					
Continental U.S.	5.48)	1.82	3.66)	2.17	1.29)
Europe (exc. Scandinavia)	6.58	2.12	4.47	2.34	1.40
Eastern Europe	7.81)*	2.43	5.38)*	2.83	2.14)†
Western Europe	6.21	1.83	4.39	2.12	(0.67)#
Southern Europe	6.74	2.80	3.94	(1.60)#	(1.04)#
All other known	4.15	1.88	2.28	(0.67)#	(1.30)#
Females					
Continental U.S.	0.94)	0.27)	0.67	0.86)	0.62
Europe (exc. Scandinavia)	1.33	0.66	0.68	1.26	0.67
Eastern Europe	1.62)*	1.04)**	0.57	1.92)*	0.97
Western Europe	1.16	(0.34)#	0.82	0.75	(0.28)#
Southern Europe	(0.99)#	(0.45)#	(0.54)#	(1.22)#	(0.89)#
All other known	(0.52)#	(-)#	(0.52)#	(0.93)#	(0.63)#

NOTE: Confidence levels in the statistical significance of differences between rates are designated as ** for 0.99, * for 0.95, and † for 0.90.

Numerator frequency less than 10.

Protestants. The higher incidence of MI among Jewish men in comparison with Catholic men is found both among the native-born and those born in Europe (Figure 13 and Table 8). While the incidence of MI is somewhat higher among European-born Jews than among Jews born in the United States, and among the European-born Catholics than among the native-born Catholics, these differences could readily have arisen from chance factors.

Occupation and Work Status

Detailed rates for the various CHD manifestations among men classified by occupation (Tables R5 and R6) present a fairly narrow range. Adjusted rates for white and blue collar workers, and for the two occupational groups showing the greatest contrast—clerical and sales workers in comparison with service workers and laborers—are summarized in Table 9. The differences that are noted are largest between the rates adjusted for age and smoking habits. In no case is there a difference suggesting statistical significance between incidence rates adjusted for age and overall physical activity class among white collar workers in comparison with blue collar workers, or among clerical and sales workers in comparison with service workers and laborers.

Working women in the HIP study population experienced a lower incidence of first MI than women who did not work (detailed rates in Table R11). Among women who had not worked in the preceding five years the rate for first MI (1.5) was almost twice that shown by the working women (0.8). In contrast, the incidence both of angina and of possible MI was almost identical among the women who worked and those who stayed at home (Table 10).

Education and Marital Status

Age-adjusted rates for all CHD manifestations in relation to highest school grade completed and to marital status among men and women are summarized

Figure 13—Average annual incidence of first MI among men in relation to place of birth and religion (age-adjusted rates per 1,000)

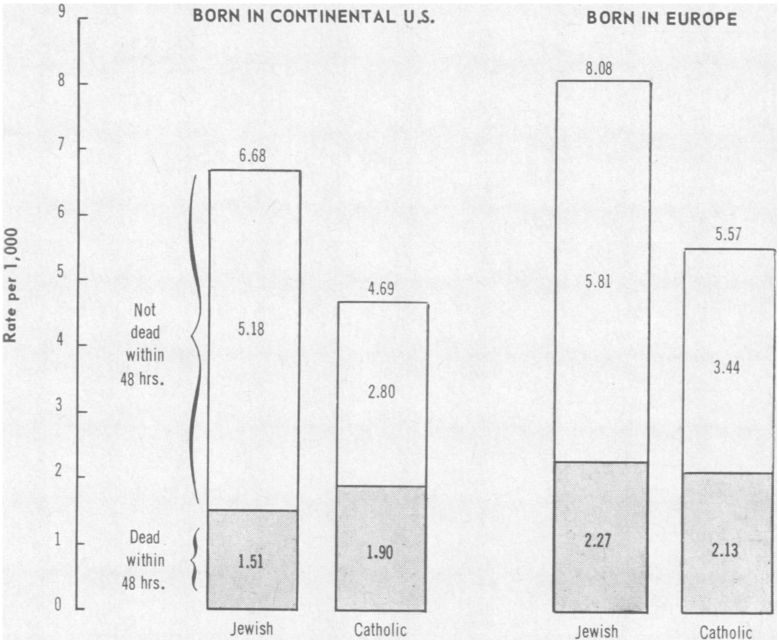


Table 8—Average annual incidence of specified manifestations of CHD in men, by place of birth and religion

	Myocardial infarction Total	Died within 48 hrs	Other	Angina	Possible MI
Continental U.S.					
Jewish	6.68)**	1.51	5.18)**	2.51	1.41
Catholic	4.69)	1.90	2.80)	2.14	1.30
Europe (exc. Scandinavia)					
Jewish	8.08)†	2.27	5.81)*	3.07	2.11
Catholic	5.57)	2.13	3.44)	1.99	(0.66)#
Eastern Europe					
Jewish	9.00	2.55	6.45	3.22	2.30

NOTE: Confidence levels in the statistical significance of differences between rates are designated as ** for 0.99, * for 0.95, and † for 0.90.

Numerator frequency less than 10.

Table 9—Average annual incidence of specified manifestations of CHD in men, by selected occupational categories—age-adjusted rates per 1,000

Occupational category	Myocardial infarction: Total	Myocardial infarction: Died within 48 hrs	Myocardial infarction: Other	Angina	Possible MI
Adjusted for age only					
White collar	5.74	1.64	4.10)†	2.19	1.32
Blue collar	5.07	1.61	3.45)†	2.26	1.25
Adjusted for age and smoking habits					
White collar	6.19)**	1.74	4.45)**	2.32	1.35
Blue collar	4.83)**	1.52	3.30)**	2.20	1.21
Adjusted for age and overall physical activity					
White collar	5.61	1.44	4.17	2.15	1.35
Blue collar	5.63	1.97	3.67	2.32	1.39
Adjusted for age only					
Clerical and sales	6.46)*	2.29)†	4.17	2.79	2.09)*
Service and laborers	4.44)*	1.34)†	3.10	1.88	1.15)*
Adjusted for age and smoking habits					
Clerical and sales	7.29)**	2.46)*	4.82)**	2.95)*	2.08)*
Service and laborers	4.09)**	1.22)*	2.87)**	1.78)*	1.06)*
Adjusted for age and overall physical activity					
Clerical and sales	6.26	1.98	4.28	2.70	1.97
Service and laborers	5.19	1.75	3.44	2.19	1.52

NOTE: Confidence levels in the statistical significance of differences between rates are designated as ** for 0.99, * for 0.95, and † for 0.90.

in Table 11 (detailed rates in Tables R3-R6, R10, R11). No differences in relation to education are noted among the men, and no important changes are produced by adjusting for smoking or physical activity in addition to age (Table R6). Among women, somewhat higher rates for rapidly fatal MIs and possible MIs are noted for the least educated in comparison with those who had completed some college, but statistical significance is only suggested by these differences ($p<0.10$).

Frequencies among unmarried men and women (including those divorced or separated, widowed, or never married) were very low, but no important differences from married persons are suggested by the rates either for men or for women.

Comment

Of the social and demographic characteristics discussed in this chapter only two—color and religion—demonstrate important differentials in incidence of new manifestations of coronary heart disease. Jews in comparison with Catholics or Protestants, and whites in comparison with nonwhites, were clearly at higher risk for both myocardial infarction and angina. The excess risk shown by Jewish men has been demonstrated to be independent of place of birth. No incidence rates by religion have, to our knowledge, previously appeared in the literature. But in 1957, Epstein, Boas, and Simpson[46] found that in a sample of male clothing workers in New York City the prevalence of manifest CHD among the Jews was twice that among the Italian men. The somewhat higher mean serum cholesterol levels found in the Jews were not judged sufficient to

Table 10—Average annual incidence of specified manifestations of CHD in women, by work status—age-adjusted rates per 1,000

Work status	Myocardial infarction: Total	Myocardial infarction: Died within 48 hrs	Myocardial infarction: Other	Angina	Possible MI
Working	0.83)*	0.25)†	0.58	1.01	0.67
Not working	1.21)	0.43)	0.79	0.85	0.63
Working	0.83)**	0.25)*	0.58	1.01	0.67
No work past 5 yrs	1.52)	0.63)	0.88	1.01	0.70

NOTE: Confidence levels in the statistical significance of differences between rates are designated as ** for 0.99, * for 0.95, and † for 0.90.

Table 11—Average annual incidence of specified manifestations of CHD in men and women, by education and by marital status—age-adjusted rates per 1,000

Education; marital status; sex	Myocardial infarction: Total	Myocardial infarction: Died within 48 hrs	Myocardial infarction: Other	Angina	Possible MI
Highest school grade completed					
Males					
Elem. school or less	4.45	1.37	3.08	2.30	1.16
Some high school	5.45	1.63	3.83	1.82	1.42
Some college	4.81	1.48	3.33	2.09	1.13
Females					
Elem. school or less	1.05	0.41)†	0.64	1.01	0.76)†
Some high school	1.06	0.30	0.76	1.09	0.63
Some college	0.80	0.18)	0.62	0.71	0.46)
Marital status					
Males					
Married	5.09	1.65	3.44)†	2.10	1.29
Other known	4.19	1.59	2.60)	1.62	(0.56)#
Females					
Married	0.92	0.30	0.63	0.86	0.61
Other known	1.00	0.43	0.57	1.08	0.57

NOTE: Confidence levels in the statistical significance of differences between rates are designated as ** for 0.99, * for 0.95, and † for 0.90.

Numerator frequency less than 10.

account for the large difference in prevalence. Case control studies[47-49] have reported a variety of findings, and Ross and Thomas[50] noted a higher prevalence of CHD among the fathers of Johns Hopkins medical students expressing their religious preference as Jewish than among Protestants or Catholics.

The higher incidence of the specified manifestations of CHD among whites as compared to nonwhites found in the HIP population is consistent with inferences which have been made from mortality data. The complexities posed by the interactions between socioenvironmental variables and cardiovascular disease are emphasized by these findings, since the lower incidence of CHD among the nonwhites (largely Negro) is noted in a population group often identified as at elevated risk for hypertension, a well-established "CHD risk factor." Parallel findings have been published by McDonough and his associates[51,52] from the Evans County, Georgia, study, where higher blood pressure and more hypertensive disease were found among Negroes than among whites, but prevalence of CHD was reported as significantly higher among white than among Negro males. These authors also reported that "low social class" white males and Negro males did not differ significantly in either CHD prevalence or cholesterol level, and concluded that the social class differences could be accounted for by differences in occupation. They viewed physical activity as the important aspect of occupation. In this connection it is to be noted that the large differential in incidence rates between white and nonwhite men found in the HIP population did not change when the rates were adjusted for over-all level of physical activity as well as age (see Table R4). In contrast with HIP findings from New York City and those from Evans County, Georgia, Gordon and Garst[53] reported no difference in the prevalence of CHD between white and Negro adults, in their analysis of Health Examination Survey data derived from examinations of a nationwide probability sample of persons aged 18-79 selected from the U.S. civilian, noninstitutional population.

In a comprehensive review of research on social and demographic factors associated with coronary heart disease, Marks[22] pointed out that most of the published data relative to demographic factors other than sex, age, and race were concerned with occupation. Her review covered a large number of studies, some of them viewing occupation as an index of socioeconomic status or stress, others as a measure of physical activity. She concluded that:

> ". . . although occupation is probably a risk factor in coronary heart disease, the association is by no means a clear and simple one, but is probably dependent on the specific characteristics of an occupation as well as the social background of the individual engaged in a given type of work." (Op. cit., p. 87.)

From many of the studies reviewed, Marks also noted that results were inconsistent, and that there was a need to control for certain occupational components, such as physical activity, while others, such as socioeconomic status, are under study. Although the HIP data on CHD incidence in men by occupation share the lack of specificity of many other investigations, the outstanding feature of the data is that the slightly higher rates found for white collar occupations in comparison with blue collar categories are evened out when the over-all physical activity of the men, independently classified, is taken into consideration. To whatever extent the occupational categories reflect "social class," no evidence is provided by the current data for differentials in incidence of the CHD manifestations discussed.

The HIP findings of an elevated risk for first MI among women who do not work in comparison with working women are consistent with observations from two other studies. The analysis of Chicago mortality data for 1951 published by Stamler and his associates[54] in 1960 noted that among both white and nonwhite women age-specific arteriosclerotic heart disease death rates were very much higher in the category "all other," which was composed largely of housewives, than in the categories referring to specific occupational groups. The possibility of a difference in heart disease rates between employed women and housewives was thereby suggested. In the previously mentioned report analyzing Health Examination Survey data, Gordon and Garst[53] found that women who were keeping house had a somewhat higher prevalence of coronary heart disease than expected, while the prevalence among working women was lower than expected.

In contrast with reports of lower arteriosclerotic heart disease death rates for married people in comparison with those single or divorced or widowed,[55,56] no important differences in incidence of manifestations of CHD are shown in the HIP data between married persons and others. On the other hand, Marks[22] has cited a number of investigations reporting no association between CHD and marital status, or a higher risk on the part of married persons, or a higher risk on the part of the widowed, divorced, or separated.

No trends are discernible in the HIP incidence data with respect to educational attainment. Other studies concerned with this variable have reported conflicting results, but the differences discussed have usually been small. In a recent publication Hinkle and his coworkers[57] dealt with the relation between occupation, education, and coronary heart disease in the large homogeneous population of men employed by the Bell System throughout the United States. They found that men who entered the organization with a college degree had a lower attack rate, death rate, and disability rate for coronary heart disease at every age, in every part of the country, and in all departments of the organization. The authors noted their belief that this difference in risk was not a result of the educational process itself, and mentioned important differences between the college-educated and other men, such as differences in body build and in smoking habits.

In summary, it may be observed that of the differentials in risk for CHD incidence observed in relation to the discussed social and demographic characteristics, only that between whites and nonwhites approaches the relative order of magnitude found with respect to smoking habits and to physical activity.

VIII. SUMMARY AND HIGHLIGHTS OF FINDINGS

Annual incidence rates of specified manifestations of coronary heart disease in men and women aged 35 to 64 years have been examined for a wide range of personal characteristics. The data are derived from a study of CHD incidence and prognosis conducted by the Health Insurance Plan of Greater New York (HIP). The population at risk consists of about 110,000 persons enrolled in the Plan. Characteristics of the population have been determined through three annual mail surveys, each consisting of a 4 per cent random sample of HIP members.

CHD case finding was directed at identifying all persons in the exposed to risk population who met the study criteria for specified manifestations for the first time during the period November, 1961-October, 1964. Case finding utilized the medical record system in HIP, hospital records, death records, and special baseline medical examinations of patients suspected of having a new CHD manifestation after review of hospital and medical records. Interviews were held with examined patients to obtain data on personal characteristics for use in calculating incidence rates; interviews with next of kin provided data for those who died before a baseline examination could be scheduled.

Incidence rates are presented for three CHD manifestations: definite myocardial infarction, definite angina, and possible myocardial infarction. Two subcategories are shown for definite MIs: those fatal within 48 hours of the attack and other definite MIs. Patients are classified as having definite angina if they meet the study's criteria based on a medical history without regard to ECG findings, if they never previously sustained an MI and are free of aortic valvular disease. The category of possible MI approximates the diagnosis of coronary insufficiency in other investigations.

The confidence with which statements are made regarding relationships observed in this study is determined primarily by the results of tests of statistical significance which take into account sampling variability. Several types of nonsampling errors have been examined and found to be relatively unimportant for most variables. Where nonsampling errors are of some consequence, the effect is to reduce a differential but not to eliminate it. Comparisons among subgroups are all based on age-adjusted rates, and in selected cases adjustments are made for differences in other personal characteristics associated with CHD.

Principal Findings of the Study

1. Men have an annual incidence rate of first MI that is five times the rate among women (5.2 per 1,000 vs. 1.0 per 1,000). About one-third of the MIs among both men and women are rapidly fatal (deaths within 48 hours of the attack). The incidence rates for angina and possible MI among men (2.0 and 1.2 per 1,000) are about twice the rates for women (0.9 and 0.6 per 1,000).

For each manifestation of CHD, the incidence rate rises sharply with increasing age over the age range 35 to 64 years. The rates of increase are greater among women than men past age 44, but the incidence of each manifestation at ages 55-64 is still substantially greater in men than in women.

2. Male cigarette smokers have twice the risk of sustaining a first MI shown by nonsmokers (7.0 per 1,000 vs. 3.3

per 1,000); the margin is similar for rapidly fatal and for other MIs. The increase in risk reaches major proportions among smokers of two or more packs of cigarettes daily. Pipe and/or cigar smokers have an MI incidence rate (5.8 per 1,000) that is intermediate between the rates for cigarette smokers and nonsmokers. Men who discontinued smoking within the previous five years and those who never smoked have similar MI incidence rates.

Cigarette smoking is also associated with a doubling in risk for angina among men and with a more modest increase in incidence of possible MI. The incidence rates for these two manifestations among pipe and/or cigar smokers are close to the rates for cigarette smokers.

Women who smoke cigarettes have twice the incidence rate of first MI shown by nonsmokers. No difference is found between smokers and nonsmokers in the risk for angina or possible MI.

Among both men and women the elevation in risk associated with cigarette smoking is more pronounced at ages 45-54 than at ages 55-64.

3. Physical inactivity among men is associated with a marked elevation in risk of sustaining a first MI. Men whose over-all level of physical activity, as judged from their activities on and off the job, is rated as "least active" have twice as high a rate of MI as "moderately active" men (8.5 per 1,000 vs. 4.2 per 1,000). Men classified as "most active" show no advantage over those "moderately active"; their MI rate is also 4.2 per 1,000.

The likelihood that a first MI will be rapidly fatal is much greater among sedentary men than among those more active; as a consequence, the risk of a rapidly fatal first MI is four times as high in the physically inactive group (3.8 per 1,000 vs. 0.9 per 1,000). The margin between least active and more active men in their rates for nonfatal MIs is considerably smaller (4.7 vs. 3.3).

Inactive men have an elevated risk of a first MI as compared with their more active contemporaries both at ages under 55 and at ages 55-64 years. The margin between the MI rates for least active and the more active men is reduced but not eliminated when examination of the MI experience is limited to those who had neither a prior manifestation of CHD nor elevated blood pressure prior to the MI. A similar narrowing of the differential is found when the comparison involves men with no prior limitation of physical activity. Differences in smoking practices, educational attainment, religion, and color do not explain the elevation in risk for first MI among sedentary men. Study of the quality of the information on physical activity suggests some bias toward an overstatement in the incidence rate for the physically inactive men, but the error is not large enough to account for the excess risk observed among these men.

No association is found between general level of physical activity and the incidence of angina. Physically inactive men have a slightly higher rate of possible MI than other men, but this differential is eliminated when comparisons are restricted to men with no history of prior CHD or no prior limitation of physical activity.

4. Men with a body weight 15 per cent or more above the average weight for those of the same age and height have about a 50 per cent greater risk of first MI than men with a relative weight under 95. High relative weight is also associated with increased rates of angina and possible MI. An increase in body weight of 20 per cent or more since age 25 identifies men with elevated risks for all three manifestations of CHD. The elevation in risk for definite MI in this respect is more pronounced for MIs not rapidly fatal than

for those resulting in death within 48 hours. None of the differentials is explained by variations in smoking practices or physical activity.

Women with high relative weights and those with comparatively large weight gains during adult life have an increased risk for angina. An increased risk for first MIs not rapidly fatal is found among the women with relatively large weight gains since age 25.

5. Incidence rates among white men are twice as high for first MI and one and one-half times as high for angina as the rates among nonwhite men. The elevated risk of MI in the white group is entirely concentrated in the episodes which are not rapidly fatal. About half of the MIs (49 per cent) among the nonwhite men are rapidly fatal, as compared with 31 per cent in the white group. Differentials between rates for white and nonwhite women are small.

Jewish men experience somewhat higher rates of MI, angina, and possible MI than white Protestants and Catholics. The differential between the MI rates is concentrated in episodes which are not fatal within 48 hours. The CHD rates among Jewish women are not markedly different from those found for non-Jewish women.

Other demographic characteristics do not show important differences in CHD rates among their various subgroups for either men or women. Variables examined include broad occupation class, place of birth, educational attainment, and marital status. An exception is work status among women. Those who did not work during the preceding five years have an MI rate twice as high as the rate for working women. These two groups do not differ in their angina and possible MI rates.

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Table R1—Annual incidence rates of specified manifestations of CHD per 1,000 males aged 35-64, by smoking habits—age-adjusted and age-specific

	Definite myocardial infarction: Total					Dead within 48 hrs					Other					Angina					Possible MI				
	All ages	Age-adj.	35-44	45-54	55-64	All ages	Age-adj.	35-44	45-54	55-64	All ages	Age-adj.	35-44	45-54	55-64	All ages	Age-adj.	35-44	45-54	55-64	All ages	Age-adj.	35-44	45-54	55-64
Total males	5.20		1.42	5.54	9.39	1.67		.31	1.61	3.46	3.51		1.11	3.93	5.93	2.03		.46	2 10	3.93	1 19		.24	1.10	2.52
Current cigarette smokers	6.46	7.01	1.83	7.93	12.16	2.12	2.34	.43	2.44	4.51	4.34	4.67	1.39	5.48	7.65	2.40	2.62	.68	2.52	5.22	1.25	1.36	.41	1.32	2.63
1 or more packs	7.05	7.62	2.25	8.53	13.02	2.16	2.38	.57	2.23	4.79	4.89	5.24	1.69	6.31	8.23	2.38	2.59	.76	2.54	4.96	1.19	1.29	.41	1.30	2.41
2 or more packs	18.44	20.80	7.47	19.91	38.12	5.34	6.53	1.44	3.87	16.01	13.10	14.27	6.03	16.04	22.11	5.59	6.64	2.03	4.15	15.61	3.48	4.05	1.01	3.47	8.61
Less than 2 packs	4.66	5.05	.95	5.96	8.93	1.64	1.78	.28	2.21	3.08	3.02	3.27	.67	3.75	5.85	1.92	2.08	.47	2.25	3.92	.92	.99	.31	.96	1.89
1 or 1½ packs	4.73	5.11	1.16	6.07	8.72	1.51	1.64	.38	1.87	2.87	3.22	3.47	.77	4.20	5.86	1.73	1.85	.50	2.19	3.15	.73	.78	.28	.83	1.35
Less than 1 pack	4.45	4.89	.39	5.58	9.49	2.01	2.23	-	3.27	3.65	2.44	2.66	.39	2.31	5.84	2.49	2.74	.39	2.46	6.06	1.47	1.60	.39	1.39	3.38
Current pipe and/or cigar smokers	6.07	5.78	1.70	6.87	9.40	1.37	1.30	.26	1.36	2.49	4.69	4.48	1.44	5.51	6.92	2.52	2.35	.24	2.20	5.20	1.47	1.37	.24	.62	3.76
Cigs in past 5 yrs	7.20	8.62	4.15	5.13	18.39	1.27	1.52	-	1.47	3.45	5.93	7.10	4.15	3.66	14.94	.53	.43	-	1.22	-	1.05	1.24	-	1.22	2.85
Other	5.88	5.49	1.19	7.20	8.60	1.39	1.29	.32	1.34	2.40	4.49	4.20	.87	5.86	6.20	2.85	2.57	.29	2.40	5.68	1.54	1.38	.29	.50	3.84
Not current smokers	3.57	3.27	.74	2.59	7.19	1.29	1.17	.15	.79	2.88	2.28	2.11	.60	1.81	4.31	1.47	1.37	.20	1.61	2.54	1.05	.95	-	1.00	2.10
Cigs in past 5 yrs	2.93	2.86	1.11	1.68	6.46	1.40	1.36	.58	.32	3.58	1.53	1.51	.53	1.36	2.88	1.16	1.16	.27	1.09	2.38	1.18	1.17	-	.55	3.45
Other smoking history	3.69	2.90	.28	2.34	6.79	1.54	1.19	-	1.08	2.78	2.16	1.71	.28	1.25	4.01	1.77	1.37	-	1.29	3.21	1.08	.83	-	.66	2.09
Never smoked	3.80	3.74	.78	3.25	7.94	1.06	1.03	-	.76	2.63	2.74	2.70	.78	2.49	5.31	1.40	1.40	.26	2.13	1.93	.95	.95	-	1.50	1.46
Subtotals																									
Not current cigs, but smoked cigs in past 5 yrs	3.57	3.59	1.60	2.30	7.61	1.38	1.39	.49	.53	3.57	2.19	2.20	1.11	1.77	4.04	1.06	1.08	.22	1.12	2.13	1.16	1.20	-	.67	3.39
No cigs past 5 yrs, other smoking history	4.59	3.95	.73	4.28	7.45	1.48	1.25	.16	1.19	2.64	3.11	2.70	.57	3.10	4.81	2.21	1.84	.14	1.74	4.13	1.27	1.04	.14	.60	2.74

Table R2—Annual incidence rates of specified manifestations of CHD per 1,000 males aged 35-64, by physical activity class—age-adjusted and age-specific

	Definite myocardial infarction															Angina					Possible MI				
	Total					Dead within 48 hrs					Other														
	All ages	Age-adj.	35-44	45-54	55-64	All ages	Age-adj.	35-44	45-54	55-64	All ages	Age-adj.	35-44	45-54	55-64	All ages	Age-adj.	35-44	45-54	55-64	All ages	Age-adj.	35-44	45-54	55-64
Total males, overall physical activity class (PAx) applicable*	5.06		1.43	5.39	9.15	1.52		.30	1.44	3.15	3.54		1.13	3.94	6.00	2.08		.47	2.13	4.10	1.21		.25	1.09	2.59
Physical activity (PAx)																									
Least active (PAx 1)	9.40	8.52	3.11	8.31	15.50	4.23	3.80	1.15	3.67	7.24	5.17	4.72	1.95	4.64	8.26	2.49	2.21	.54	2.02	4.59	1.79	1.52	-	1.21	3.89
Intermediate (PAx 2)	4.30	4.19	.95	5.15	7.00	1.08	1.04	.07	.96	2.34	3.22	3.15	.88	4.18	4.65	2.19	2.12	.63	2.04	4.14	1.22	1.18	.32	1.13	2.37
Most active (PAx 3)	3.87	4.20	1.34	4.19	7.78	.74	.81	.23	.83	1.50	3.12	3.39	1.11	3.36	6.28	1.80	1.98	.32	2.28	3.72	.93	1.02	.26	1.00	2.04
Alternative overall physical activity class (PAx')																									
Least active (PAx' 1)	8.08	7.31	2.25	7.76	13.00	3.54	3.15	.75	3.17	6.12	4.54	4.15	1.50	4.59	6.88	2.27	2.01	.35	2.01	4.14	1.54	1.31	-	1.04	3.35
1st intermediate (PAx' 2)	4.62	4.10	1.82	3.48	7.71	1.51	1.33	.65	.99	2.60	3.11	2.77	1.17	2.49	5.11	2.98	2.68	1.18	2.66	4.63	1.35	1.17	.20	1.24	2.33
2nd intermediate (PAx' 3)	4.25	4.47	1.50	5.05	7.41	.78	.83	.14	.99	1.48	3.47	3.64	1.36	4.06	5.93	1.84	1.99	.39	1.99	4.07	1.14	1.22	.32	1.29	2.28
Most active (PAx' 4)	2.94	3.43	.53	4.15	6.12	.23	.29	-	.26	.69	2.71	3.14	.53	3.88	5.43	1.61	1.86	.36	2.18	3.38	.82	.94	.36	.71	2.01
Job-connected PA (PAJ)																									
Least active (PAJ 1)	7.22	7.05	2.16	7.75	12.22	2.55	2.48	.64	2.57	4.66	4.68	4.57	1.52	5.18	7.56	2.17	2.13	.51	1.89	4.52	1.68	1.65	.34	1.39	3.67
1st intermediate (PAJ 2)	4.77	4.76	1.43	4.95	8.64	1.45	1.44	.09	1.35	3.23	3.32	3.32	1.34	3.60	5.41	2.02	2.02	.25	2.42	3.81	1.00	1.00	.08	1.06	2.09
2nd intermediate (PAJ 3)	3.35	3.45	1.00	4.20	5.54	.61	.64	.11	.49	1.47	2.74	2.82	.89	3.71	4.07	2.10	2.17	.70	2.08	4.18	1.09	1.12	.30	.90	2.48
Most active (PAJ 4)	3.78	3.80	.78	2.78	8.83	.95	.96	.33	.55	2.25	2.82	2.84	.45	2.24	6.58	1.99	1.99	.45	2.22	3.70	.84	.84	.30	.81	1.58
Off-job PA (PAoJ)																									
Least active (PAoJ 1)	10.21	8.86	2.65	8.90	16.38	4.83	4.16	1.11	4.12	7.93	5.38	4.70	1.54	4.78	8.45	2.81	2.42	.79	2.28	4.66	2.32	1.85	-	1.51	4.64
1st intermediate (PAoJ 2)	5.81	5.30	1.80	5.57	9.22	2.37	2.12	.53	2.12	4.06	3.44	3.18	1.27	3.45	5.16	2.29	2.07	.59	2.15	3.85	1.03	.91	.10	.97	1.86
2nd intermediate (PAoJ 3)	3.57	3.61	.73	4.51	6.00	.63	.64	.09	.55	1.44	2.94	2.97	.64	3.96	4.56	1.80	1.83	.56	1.76	3.50	1.01	1.02	.32	1.16	1.74
Most active (PAoJ 4)	3.88	4.65	1.42	4.97	8.17	.58	.65	.15	1.00	.82	3.30	4.00	1.28	3.96	7.35	1.62	2.06	.20	2.33	4.08	1.03	1.34	.34	.97	3.09
NO PRIOR CHD																									
Total, PAx applicable	4.00		1.31	4.44	6.88	1.06		.27	1.07	2.08	2.93		1.04	3.38	4.80	1.91		.45	1.96	3.75	.87		.20	.89	1.70
Least active (PAx 1)	6.84	6.32	2.97	6.79	10.05	2.86	2.61	.99	2.91	4.32	3.98	3.71	1.98	3.88	5.73	2.26	2.01	.54	1.92	4.04	.97	.83	-	.82	1.94
Intermediate (PAx 2)	3.60	3.51	.83	4.56	5.63	.81	.78	.07	.74	1.74	2.79	2.74	.76	3.82	3.89	1.99	1.93	.63	1.85	3.71	.87	.84	.25	.88	1.55
Most active (PAx 3)	3.15	3.42	1.23	3.24	6.47	.54	.58	.23	.54	1.08	2.62	2.84	1.00	2.70	5.39	1.68	1.85	.26	2.09	3.60	.82	.90	.21	.94	1.73
NO PRIOR LIMITATION OF PHYSICAL ACTIVITY																									
Total, PAx applicable	4.13		1.21	4.35	7.47	1.16		.27	1.06	2.39	2.97		.94	3.29	5.08	1.84		.47	1.86	3.59	1.05		.25	.99	2.15
Least active (PAx 1)	6.98	6.33	2.40	5.97	11.66	2.86	2.59	.98	2.48	4.79	4.12	3.74	1.42	3.49	6.92	1.89	1.69	.54	1.49	3.44	1.27	1.09	-	.95	2.67
Intermediate (PAx 2)	3.57	3.48	.76	4.31	5.78	.97	.93	.07	.80	2.15	2.60	2.55	.69	3.51	3.63	1.99	1.93	.63	1.83	3.72	1.11	1.07	.32	1.07	2.06
Most active (PAx 3)	3.47	3.70	1.23	3.60	6.91	.64	.63	.23	.62	1.13	2.83	3.08	1.00	2.98	5.78	1.67	1.84	.32	2.07	3.50	.89	.97	.26	.94	1.92

* The classification of over-all and of job-connected physical activity is applicable only to those men known to have been employed within the five years preceding diagnosis of the given CHD manifestation (numerator) or preceding the given mail survey (denominator).

Table R3—Annual incidence rates of specified manifestations of CHD per 1,000 males aged 35-64, by demographic characteristics: color, religion, place of birth, and marital status—age-adjusted and age-specific

	Definite myocardial infarction: Total					Dead within 48 hrs					Other					Angina					Possible MI				
	All ages	Age-adj.	35-44	45-54	55-64	All ages	Age-adj.	35-44	45-54	55-64	All ages	Age-adj.	35-44	45-54	55-64	All ages	Age-adj.	35-44	45-54	55-64	All ages	Age-adj.	35-44	45-54	55-64
Total males	5.20		1.42	5.54	9.39	1.67		.31	1.61	3.46	3.51		1.11	3.93	5.93	2.03		.46	2.10	3.93	1.19		.24	1.10	2.52
Color																									
White	5.48	5.39	1.55	5.72	9.67	1.69	1.66	.31	1.54	3.45	3.79	3.73	1.24	4.18	6.22	2.17	2.14	.48	2.25	4.10	1.24	1.22	.20	1.15	2.61
Nonwhite	2.20	2.66	.74	3.03	4.55	1.06	1.31	.37	1.26	2.53	1.15	1.35	.37	1.77	2.02	1.07	1.36	.37	1.03	3.03	.98	1.19	.56	.78	2.53
Religion																									
Total: Catholic	4.03	4.32	1.19	4.93	7.37	1.50	1.63	.27	1.42	3.54	2.53	2.69	.91	3.51	3.83	1.75	1.88	.50	2.15	3.27	1.01	1.08	.32	.99	2.16
Jewish	6.96	6.38	1.99	6.48	11.60	1.65	1.49	.27	1.52	2.96	5.30	4.89	1.72	4.97	8.65	2.79	2.53	.46	2.53	5.16	1.60	1.42	-	1.26	3.41
Protestant	4.12	4.13	1.44	4.31	7.17	1.60	1.60	.48	1.33	3.29	2.52	2.53	.96	2.98	3.88	1.57	1.55	.48	1.35	3.16	.87	.87	.32	.85	1.58
White only: Catholic	4.24	4.54	1.22	5.18	7.79	1.57	1.71	.29	1.49	3.70	2.67	2.83	.93	3.69	4.09	1.84	1.97	.54	2.20	3.50	1.05	1.13	.34	1.04	2.23
Jewish	7.11	6.56	2.00	6.59	12.06	1.69	1.54	.27	1.54	3.07	5.42	5.02	1.73	5.05	8.99	2.85	2.61	.46	2.57	5.38	1.63	1.47	-	1.29	3.56
Protestant	5.57	5.03	2.50	5.13	7.99	1.97	1.64	.42	1.28	3.58	3.61	3.39	2.08	3.85	4.41	1.66	1.45	.42	1.62	2.54	.66	.55	-	.65	1.13
Place of birth																									
Continental U.S.	4.86	5.48	1.41	5.22	10.74	1.55	1.82	.28	1.51	4.07	3.31	3.66	1.14	3.72	6.67	1.92	2.17	.53	2.10	4.35	1.09	1.29	.28	.98	2.95
Europe*	7.76	6.58	2.44	9.19	8.40	2.51	2.12	.81	2.89	2.74	5.25	4.47	1.63	6.30	5.65	3.34	2.34	-	3.33	4.05	1.87	1.40	-	2.22	2.15
Western Europe	7.23	6.21	1.23	10.08	7.48	1.92	1.83	1.23	2.33	1.92	5.31	4.39	-	7.75	5.56	2.88	2.12	-	3.33	3.27	1.06	.67	-	.83	1.31
Southern Europe	5.72	6.74	1.04	12.96	5.95	2.49	2.80	-	5.56	2.78	3.23	3.94	1.04	7.41	3.17	2.26	1.60	-	1.96	3.17	1.00	1.04	-	1.96	1.19
Eastern Europe	9.33	7.81	5.80	7.58	10.56	3.07	2.43	1.45	2.53	3.52	6.27	5.38	4.35	5.05	7.04	4.38	2.83	-	3.70	5.33	3.11	2.14	-	3.17	3.56
All other known	4.06	4.15	.94	5.77	6.06	1.94	1.88	.47	1.92	3.54	2.12	2.28	.47	3.85	2.53	.72	.67	-	.68	1.52	1.25	1.30	-	2.04	2.02
Marital status																									
Married	5.07	5.09	1.32	5.33	9.39	1.64	1.65	.30	1.53	3.42	3.43	3.44	1.02	3.79	5.97	2.09	2.10	.41	2.20	4.13	1.29	1.29	.25	1.17	2.77
Other than married	4.23	4.19	1.41	4.85	6.76	1.62	1.59	.20	1.62	3.26	2.61	2.60	1.21	3.23	3.50	1.64	1.62	.81	1.43	2.88	.57	.56	.20	.61	.96

* Excluding Scandinavian countries.

Table R4—Adjusted annual incidence rates of specified manifestations of CHD per 1,000 males aged 35-64 and corresponding morbidity ratios,+ by demographic characteristics: color, religion, place of birth, and marital status

	Definite myocardial infarction												Angina				Possible MI			
	Total				Dead within 48 hrs				Other											
	Age-adjusted incid. rates		Morbidity ratio		Age-adjusted incid. rates		Morbidity ratio		Age-adjusted incid. rates		Morbidity ratio		Age-adjusted incid. rates		Morbidity ratio		Age-adjusted incid. rates		Morbidity ratio	
	A*	B**	A	B	A*	B**	A	B	A*	B**	A	B	A*	B**	A	B	A*	B**	A	B
Color																				
White	5.33	5.39	102	104	1.65	1.58	99	95	3.68	3.82	105	109	2.12	2.19	104	108	1.21	1.23	102	103
Nonwhite	2.48	2.72	48	52	1.15	1.29	69	77	1.32	1.44	38	41	1.19	1.39	59	68	1.09	1.22	92	103
Religion																				
Catholic	3.92	4.85	75	93	1.49	1.92	89	115	2.43	2.93	69	83	1.77	1.98	87	98	1.02	1.17	86	98
Jewish	8.16	6.36	157	122	1.75	1.36	105	81	6.41	5.01	183	143	3.08	2.55	152	126	1.52	1.45	128	122
Protestant	4.04	4.25	78	82	1.56	1.78	93	107	2.48	2.47	71	70	1.45	1.61	71	79	.79	.88	66	74
Place of birth																				
Continental U.S.	5.45	5.33	105	102	1.81	1.61	108	96	3.64	3.72	104	106	2.16	2.22	106	109	1.27	1.28	107	108
Europe++	8.33	7.17	160	138	2.87	2.36	172	141	5.46	4.82	156	137	2.44	2.41	120	119	1.41	1.67	118	140
Western Europe	6.75	6.36	130	122	2.30	1.59	138	95	4.44	4.77	126	136	2.33	2.04	115	100	.54	.74	45	62
Southern Europe	4.47	7.92	86	152	1.76	3.82	105	229	2.71	4.09	77	117	1.21	1.88	60	93	.60	1.57	50	132
Eastern Europe	10.95	9.44	211	182	2.31	3.27	138	196	8.64	6.17	246	176	3.40	2.92	167	144	3.09	2.37	260	199
All other known	6.11	4.01	117	77	2.91	1.92	174	115	3.20	2.10	91	60	.89	.93	44	46	1.54	2.24	129	188
Marital status																				
Married	5.15	5.08	99	98	1.67	1.55	100	93	3.49	3.52	99	100	2.12	2.16	104	106	1.30	1.32	109	111
Other than married	4.15	3.98	80	77	1.43	1.40	86	84	2.72	2.58	77	74	1.46	1.67	72	82	.52	.54	44	45

+ Ratio of specified adjusted incidence rate to observed rate for all males × 100.
* A—adjusted for age and smoking habits.
** B—adjusted for age and over-all physical activity class (PAx).
+ + Excluding Scandinavian countries.

Table R5—Annual incidence rates of specified manifestations of CHD per 1,000 males aged 35-64, by education and occupation—age-adjusted and age-specific

	Definite myocardial infarction															Angina					Possible MI				
	Total					Dead within 48 hrs					Other														
	All ages	Age-adj.	35-44	45-54	55-64	All ages	Age-adj.	35-44	45-54	55-64	All ages	Age-adj.	35-44	45-54	55-64	All ages	Age-adj.	35-44	45-54	55-64	All ages	Age-adj.	35-44	45-54	55-64
Total males	5.20		1.42	5.54	9.39	1.67		.31	1.61	3.46	3.51		1.11	3.93	5.93	2.03		.46	2.10	3.93	1.19		.24	1.10	2.52
Education																									
Elementary school or less	6.14	4.45	.81	5.62	7.44	1.91	1.37	-	2.08	2.16	4.23	3.08	.81	3.54	5.28	3.16	2.30	.81	2.35	4.13	1.58	1.16	.41	1.23	2.02
Some high school	4.49	5.45	1.52	5.41	10.30	1.25	1.63	.29	1.16	3.82	3.24	3.83	1.22	4.25	6.47	1.54	1.82	.55	2.17	2.98	1.08	1.42	.25	.84	3.64
Some college	4.64	4.81	1.33	4.69	9.19	1.39	1.48	.33	1.02	3.44	3.25	3.33	.99	3.67	5.76	1.99	2.09	.27	1.94	4.59	1.09	1.13	.20	1.25	2.15
Occupation																									
White collar	5.93	5.74	1.75	5.74	10.61	1.69	1.64	.32	1.29	3.70	4.24	4.10	1.43	4.45	6.91	2.26	2.19	.33	1.82	5.01	1.37	1.32	.07	1.20	3.05
Professional, technical	5.40	5.24	1.75	4.95	9.85	1.38	1.32	.23	.90	3.16	4.02	3.92	1.52	4.05	6.69	1.80	1.75	.35	1.90	3.32	.94	.92	-	1.30	1.59
Managers, officials and proprietors	6.12	5.82	1.83	6.84	9.41	1.53	1.46	.73	1.77	1.96	4.59	4.36	1.10	5.08	7.45	2.65	2.64	-	1.85	6.99	1.38	1.38	-	.93	3.70
Clerical and sales	6.69	6.46	1.69	6.02	12.80	2.32	2.29	.24	1.47	5.80	4.37	4.17	1.45	4.55	7.00	2.78	2.79	.49	1.71	7.09	2.09	2.09	.24	1.24	5.51
Blue collar	4.79	5.07	1.32	5.61	8.96	1.52	1.61	.30	1.77	3.03	3.27	3.45	1.02	3.84	5.93	2.15	2.26	.60	2.69	3.84	1.19	1.25	.38	1.11	2.54
Craftsmen, foremen, etc.	5.83	5.32	1.20	5.61	9.98	1.81	1.64	.40	1.44	3.38	4.02	3.68	.80	4.17	6.60	2.51	2.38	1.21	2.79	3.33	1.43	1.29	.20	1.31	2.63
Operatives, etc.	5.95	5.67	2.37	6.59	8.56	2.04	1.93	.39	2.56	3.03	3.90	3.74	1.97	4.03	5.53	2.97	2.80	.79	3.50	4.47	1.45	1.35	.79	.92	2.61
Service workers and laborers	3.36	4.44	.97	4.89	8.10	.99	1.34	.22	1.45	2.55	2.37	3.10	.74	3.44	5.56	1.39	1.88	.30	2.01	3.73	.87	1.15	.30	1.07	2.33

Table R6—Adjusted annual incidence rates of specified manifestations of CHD per 1,000 males aged 35-64 and corresponding morbidity ratios,+ by education and occupation

	Definite myocardial infarction: Total, Age-adjusted incid. rates A*	Total, Age-adjusted incid. rates B**	Total, Morbidity ratio A	Total, Morbidity ratio B	Dead within 48 hrs, Age-adjusted incid. rates A*	Dead within 48 hrs, Age-adjusted incid. rates B**	Dead within 48 hrs, Morbidity ratio A	Dead within 48 hrs, Morbidity ratio B	Other, Age-adjusted incid. rates A*	Other, Age-adjusted incid. rates B**	Other, Morbidity ratio A	Other, Morbidity ratio B	Angina: Age-adjusted incid. rates A*	Angina: Age-adjusted incid. rates B**	Angina: Morbidity ratio A	Angina: Morbidity ratio B	Possible MI: Age-adjusted incid. rates A*	Possible MI: Age-adjusted incid. rates B**	Possible MI: Morbidity ratio A	Possible MI: Morbidity ratio B
Education																				
Elementary school or less	4.17	5.08	80	98	1.35	1.59	81	95	2.82	3.49	80	99	2.35	2.41	116	119	1.07	1.27	90	107
Some high school	5.29	5.86	102	113	1.62	1.86	97	111	3.66	4.00	104	114	1.80	1.90	89	94	1.44	1.53	121	129
Some college	5.26	4.52	101	87	1.61	1.18	96	71	3.65	3.34	104	95	2.35	2.15	116	106	1.20	1.18	101	99
Occupation																				
White collar	6.19	5.61	119	108	1.74	1.44	104	86	4.45	4.17	127	119	2.32	2.15	114	106	1.35	1.35	113	113
Professional, technical	5.80	5.20	112	100	1.41	1.18	84	71	4.39	4.03	125	115	1.84	1.83	91	90	.88	1.18	74	99
Managers, officials and proprietors	6.09	6.26	117	120	1.50	1.52	90	91	4.59	4.74	131	135	2.70	2.80	133	138	1.34	1.42	113	119
Clerical and sales	7.29	6.26	140	120	2.46	1.98	147	119	4.82	4.28	137	122	2.95	2.70	145	133	2.08	1.97	175	166
Blue collar	4.83	5.63	93	108	1.52	1.97	91	118	3.30	3.67	94	105	2.20	2.32	108	114	1.21	1.39	102	117
Craftsmen, foremen, etc.	6.07	6.53	117	126	1.93	2.47	116	148	4.13	4.06	118	116	2.69	2.49	133	123	1.54	1.50	129	126
Operatives, etc.	5.32	5.56	102	107	1.80	1.90	108	114	3.52	3.66	100	104	2.77	2.81	136	138	1.34	1.33	113	112
Service workers and laborers	4.09	5.19	79	100	1.22	1.75	73	105	2.87	3.44	82	98	1.78	2.19	88	108	1.06	1.52	89	128

+ Ratio of specified adjusted incidence rate to observed rate for all males × 100.
* A—adjusted for age and smoking habits.
** B—adjusted for age and over-all physical activity class (PAx).

Table R7—Annual incidence rates of specified manifestations of CHD per 1,000 males aged 35-64, by relative weight and weight history—age-adjusted and age-specific

	Definite myocardial infarction															Angina					Possible MI				
	Total					Dead within 48 hrs					Other														
	All ages	Age-adj.	35-44	45-54	55-64	All ages	Age-adj.	35-44	45-54	55-64	All ages	Age-adj.	35-44	45-54	55-64	All ages	Age-adj.	35-44	45-54	55-64	All ages	Age-adj.	35-44	45-54	55-64
Total males	5.20		1.42	5.54	9.39	1.67		.31	1.61	3.46	3.51		1.11	3.93	5.93	2.03		.46	2.10	3.93	1.19		.24	1.10	2.52
Relative weight																									
Less than 95	5.20	4.73	.97	4.97	9.00	1.89	1.68	.12	1.69	3.58	3.31	3.04	.85	3.28	5.42	2.02	1.81	.36	1.55	3.98	1.25	1.15	.36	1.14	2.15
95 - 114	4.66	4.76	1.46	4.48	9.11	1.40	1.45	.29	1.10	3.29	3.25	3.31	1.17	3.38	5.82	1.89	1.92	.46	2.07	3.59	1.06	1.09	.17	.77	2.68
115+	5.55	6.25	1.67	9.24	8.12	1.29	1.46	.36	2.17	1.92	4.25	4.79	1.31	7.06	6.20	2.42	2.74	.60	2.76	5.44	1.54	1.77	.24	2.21	3.17
Weight history																									
Less than 10% increase	2.98	3.32	1.30	3.60	5.44	.81	.90	.26	.72	1.89	2.18	2.42	1.04	2.88	3.55	1.19	1.37	.26	1.69	2.38	.62	.69	.13	.48	1.67
10 - 19% increase	4.01	4.55	1.45	2.97	10.28	1.22	1.44	.48	.46	3.81	2.80	3.11	.97	2.51	6.47	2.17	2.40	.58	2.07	5.10	1.27	1.48	.29	.75	3.91
20+ % increase	6.91	6.44	1.55	7.29	11.35	1.74	1.60	.11	1.88	3.07	5.16	4.84	1.44	5.41	8.28	3.12	2.92	.78	3.05	5.48	1.91	1.77	.33	1.73	3.66
Age at maximum weight ≤ age at minimum weight	5.44	5.74	1.47	6.83	9.57	2.14	2.28	.53	2.36	4.31	3.30	3.46	.95	4.48	5.26	2.30	2.53	.21	2.21	5.87	1.32	1.42	.32	1.59	2.59
Relative weight less than 115	4.82	4.75	1.33	4.62	9.07	1.55	1.52	.25	1.27	3.39	3.27	3.23	1.09	3.35	5.68	1.93	1.90	.44	1.92	3.72	1.11	1.10	.22	.87	2.50
Less than 10% increase	3.20	3.43	1.44	3.49	5.77	.94	1.01	.32	.81	2.10	2.25	2.42	1.12	2.69	3.67	1.24	1.41	.16	1.90	2.38	.66	.68	.16	.27	1.85
10 - 19% increase	4.10	4.54	1.27	2.80	10.67	1.21	1.41	.25	.50	3.93	2.89	3.13	1.02	2.30	6.74	2.19	2.37	.77	1.73	5.20	1.23	1.41	.13	.61	4.05
20+ % increase	6.31	5.87	1.62	5.56	11.44	1.83	1.67	.16	1.54	3.67	4.48	4.20	1.46	4.01	7.77	2.99	2.75	.65	2.94	5.16	1.81	1.67	.33	1.52	3.54
Age at maximum weight ≤ age at minimum weight	4.51	4.72	1.35	5.44	7.93	1.42	1.50	.37	1.50	2.88	3.09	3.22	.98	3.95	5.04	2.11	2.28	.12	1.99	5.39	1.18	1.25	.37	1.13	2.50
Relative weight 115+	5.55	6.25	1.67	9.24	8.12	1.29	1.46	.36	2.17	1.92	4.25	4.79	1.31	7.06	6.20	2.42	2.74	.60	2.76	5.44	1.54	1.77	.24	2.21	3.17
Less than 10% increase	1.49	2.16	.76	3.03	2.78	-	-	-	-	-	1.49	2.16	.76	3.03	2.78	.99	1.06	.76	-	2.78	.50	1.08	-	3.03	-
10 19% increase	4.28	6.62	2.22	6.67	11.90	1.53	1.85	1.33	-	4.76	2.75	4.77	.89	6.67	7.14	2.14	4.40	-	6.67	7.14	1.53	2.27	.89	1.67	4.76
20+ % increase	8.43	8.42	1.45	13.19	10.97	1.64	1.65	-	3.30	1.63	6.79	6.76	1.45	9.89	9.35	3.37	3.34	1.09	3.37	6.14	2.20	2.18	-	2.62	4.39
Age at maximum weight ≤ age at minimum weight	3.49	3.72	.79	7.53	2.56	.78	1.13	-	1.08	2.56	2.71	2.59	.79	6.45	-	3.21	5.38	79	2.20	15.15	2.01	2.91	-	3.33	6.06

Table R8—Adjusted annual incidence rates of specified manifestations of CHD per 1,000 males aged 35-64 and corresponding morbidity ratios,+ by relative weight and weight history

	Definite myocardial infarction												Angina				Possible MI			
	Total				Dead within 48 hrs				Other											
	Age-adjusted incid. rates		Morbidity ratio		Age-adjusted incid. rates		Morbidity ratio		Age-adjusted incid. rates		Morbidity ratio		Age-adjusted incid. rates		Morbidity ratio		Age-adjusted incid. rates		Morbidity ratio	
	A*	B**	A	B	A*	B**	A	B	A*	B**	A	B	A*	B**	A	B	A*	B**	A	B
Relative weight																				
Less than 95	4.53	4.69	87	90	1.63	1.62	98	97	2.91	3.07	83	87	1.82	1.87	90	92	1.13	1.21	95	102
95 - 114	4.98	4.84	96	93	1.50	1.45	90	87	3.48	3.39	99	97	2.01	1.97	99	97	1.13	1.12	95	94
115+	6.18	6.77	119	130	1.48	1.57	89	94	4.69	5.20	134	148	2.62	2.85	129	140	1.66	1.79	139	150
Weight history																				
Less than 10% increase	3.61	3.53	69	68	.84	1.05	50	63	2.77	2.49	79	71	1.29	1.56	64	77	.67	.76	56	64
10 - 19% increase	4.67	4.64	90	89	1.43	1.44	86	86	3.25	3.20	93	91	2.37	2.43	117	120	1.52	1.52	128	128
20+ % increase	6.81	6.42	131	123	1.73	1.51	104	90	5.07	4.91	144	140	2.98	3.00	147	148	1.82	1.79	153	150
Age at maximum weight ≤ age at minimum weight	5.56	4.59	107	88	2.21	1.36	132	81	3.35	3.24	95	92	2.47	2.59	122	128	1.34	1.38	113	116

+ Ratio of specified adjusted incidence rate to observed rate for all males × 100.
* A—adjusted for age and smoking habits.
** B—adjusted for age and over-all physical activity class (PAx).

Table R9—Adjusted annual incidence rates of specified manifestations of CHD per 1,000 males aged 35-64 and corresponding morbidity ratios, by smoking habits and physical activity class

		Definite myocardial infarction						Angina		Possible MI	
		Total		Dead within 48 hrs		Other					
		Adjusted incid.rate	Morbidity ratio	Adjusted incid.rate	Morbidity ratio	Adjusted incid.rate	Morbidity ratio	Adjusted incid.rate	Morbidity ratio	Adjusted incid.rate	Morbidity ratio
Total males, overall physical activity class applicable		5.06	100	1.52	100	3.54	100	2.08	100	1.21	100
Physical activity class, adjusted for age and smoking											
	Least active (PAx 1)	8.79	174	3.89	256	4.90	138	2.20	106	1.58	131
	Intermediate (PAx 2)	4.15	82	.99	65	3.17	90	2.13	102	1.16	96
	Most active (PAx 3)	4.46	88	.83	55	3.63	103	2.15	103	1.06	88
Smoking category, adjusted for age and physical activity											
All cigarette smokers		6.78	134	2.09	137	4.69	132	2.71	130	1.38	114
2 or more packs		21.84	432	5.98	393	15.86	448	7.60	365	4.14	342
Less than 2 packs		4.92	97	1.58	104	3.34	94	2.17	104	1.03	85
Not cigarette smokers		3.72	74	1.08	71	2.65	75	1.61	77	1.05	87
Smoked cigarettes in past 5 yrs		3.55	70	1.20	79	2.35	66	1.18	57	1.20	99
Other smoking history		3.84	76	1.12	74	2.73	77	1.90	91	1.03	85
Never smoked		3.88	77	1.02	67	2.86	81	1.44	69	.99	82
Smoking category and physical activity class, age-adjusted	Physical activity class										
All cigarette smokers	Least active	10.89	215	5.18	341	5.72	162	2.31	111	1.64	136
	Intermediate	5.80	115	1.37	90	4.42	125	2.83	136	1.46	121
	Most active	5.77	114	1.22	80	4.55	129	2.74	132	1.10	91
2 or more packs	Least active	39.09	773	15.59	1026	23.50	664	4.97	239	5.65	467
	Intermediate	11.27	223	3.79	249	7.48	211	5.09	245	3.87	320
	Most active	24.09	476	2.89	190	21.20	599	12.20	587	3.68	304
Less than 2 packs	Least active	7.61	150	4.08	268	3.53	100	2.05	99	1.27	105
	Intermediate	4.71	93	.87	57	3.83	108	2.37	114	.98	81
	Most active	3.85	76	1.06	70	2.78	79	1.95	94	.89	74
Not cigarette smokers	Least active	6.33	125	2.57	169	3.76	106	2.14	103	1.44	119
	Intermediate	3.07	61	.80	53	2.27	64	1.67	80	.96	79
	Most active	3.01	59	.52	34	2.48	70	1.32	63	.92	76
Cigs in past 5 yrs	Least active	5.92	117	4.14	272	1.78	50	1.65	79	1.30	107
	Intermediate	1.88	37	.52	34	1.35	38	.79	38	1.32	109
	Most active	3.95	78	.19	12	3.76	106	1.31	63	.98	81
Other smoking history	Least active	6.08	120	2.35	155	3.73	105	2.03	98	1.21	100
	Intermediate	3.87	76	1.02	67	2.85	81	1.98	95	.93	77
	Most active	2.60	51	.57	37	2.03	57	1.75	84	1.00	83
Never smoked	Least active	8.15	161	2.50	164	5.65	160	2.28	110	1.84	152
	Intermediate	2.55	50	.66	43	1.89	53	1.74	84	.79	65
	Most active	3.08	60	.57	37	2.51	71	79	38	.77	64

Table R10—Annual incidence rates of specified manifestations of CHD per 1,000 females aged 35-64, by demographic characteristics: color, religion, place of birth, and marital status—age-adjusted and age-specific

		Definite myocardial infarction															Angina					Possible MI				
		Total					Dead within 48 hrs					Other														
		All ages	Age-adj.	35-44	45-54	55-64	All ages	Age-adj.	35-44	45-54	55-64	All ages	Age-adj.	35-44	45-54	55-64	All ages	Age-adj.	35-44	45-54	55-64	All ages	Age-adj.	35-44	45-54	55-64
Total females		1.00		.07	.68	2.68	.35		-	.28	.90	.65		.07	.40	1.78	.92		.11	.80	2.16	.62		.07	.54	1.48
Color																										
White		1.04	1.01	.05	.61	2.82	.36	.35	-	.27	.91	.68	.66	.05	.34	1.91	.98	.95	11	.84	2.24	.67	.66	.08	.54	1.58
Nonwhite		.49	.61	.14	.88	.81	.07	.09	-	.22	-	.42	.52	.14	.66	.81	.63	.85	.14	.67	2.06	.35	.48	-	.67	.82
Religion																										
Total:	Catholic	.78	.88	.09	.58	2.33	.34	.39	-	.32	1.00	.44	.49	.09	.26	1.33	.75	.83	.09	.80	1.83	.73	.80	.14	.64	1.92
	Jewish	1.14	1.01	-	.59	2.91	.22	.19	-	.14	.52	.92	.81	-	.46	2.39	1.27	1.15	.15	.96	2.75	.58	.51	-	.41	1.34
	Protestant	.82	.83	.13	.93	1.60	.38	.40	-	.53	.71	.43	.44	.13	.40	.89	.62	.63	.13	.53	1.43	.53	.54	-	.66	1.08
White only:	Catholic	.83	.92	.10	.63	2.40	.35	.39	-	.34	.98	.48	.53	.10	.29	1.42	.79	.86	.10	.86	1.87	.79	.86	.15	.69	2.05
	Jewish	1.17	1.05	-	.60	3.06	.22	.20	-	.14	.54	.95	.85	-	.46	2.52	1.31	1.19	.15	.98	2.88	.59	.53	-	.42	1.40
	Protestant	1.15	.93	-	.77	2.36	.77	.65	-	.77	1.31	.38	.28	-	-	1.05	.48	.38	-	.26	1.05	.58	.48	-	.51	1.05
Place of birth																										
Continental U.S.		.80	.94	.08	.60	2.54	.23	.27	-	.25	.64	.56	.67	.08	.35	1.91	.76	.86	.10	.78	1.98	.55	.62	.08	.55	1.44
Europe*		2.20	1.33	-	.99	3.57	1.05	.66	-	.56	1.65	1.15	.68	-	.42	1.92	1.81	1.26	.35	1.14	2.64	1.07	.67	-	.57	1.70
Western Europe		1.73	1.16	-	1.11	2.74	.50	.34	-	.37	.75	1.24	.82	-	.74	1.99	1.25	.75	-	.37	2.29	.37	.28	-	.37	.51
Southern Europe		1.45	.99	-	.61	2.82	.72	.45	-	-	1.69	.72	.54	-	.61	1.13	1.69	1.22	-	1.21	2.82	1.45	.89	-	-	3.39
Eastern Europe		3.00	1.62	-	1.09	4.48	1.73	1.04	-	1.09	2.34	1.27	.57	-	-	2.14	2.39	1.92	1.28	1.85	2.86	1.55	.97	-	1.11	2.04
All other known		.52	.52	-	.95	.57	-					.52	.52	-	.95	.57	1.04	.93	-	.48	2.83	.69	.63	-	.48	1.70
Marital status																										
Married		.83	.92	.08	.68	2.37	.27	.30	-	.29	.69	.56	.63	.08	.39	1.68	.79	.86	.13	.76	1.97	.56	.61	.08	.59	1.36
Other than married		1.52	1.00	-	.45	3.08	.64	.43	-	.23	1.27	.88	.57	-	.23	1.81	1.49	1.08	-	1.02	2.60	.85	.57	-	.34	1.67

* Excluding Scandinavian countries.

Table R11—Annual incidence rates of specified manifestations of CHD per 1,000 females aged 35-64, by selected personal characteristics: smoking habits, work status, education, relative weight, and weight history—age-adjusted and age-specific

	Definite myocardial infarction: Total					Dead within 48 hrs					Other					Angina					Possible MI				
	All ages	Age-adj.	35-44	45-54	55-64	All ages	Age-adj.	35-44	45-54	55-64	All ages	Age-adj.	35-44	45-54	55-64	All ages	Age-adj.	35-44	45-54	55-64	All ages	Age-adj.	35-44	45-54	55-64
Total females	1.00		.07	.68	2.68	.35		-	.28	.90	.65		.07	.40	1.78	.92		.11	.80	2.16	.62		.07	.54	1.48
Smoking habits																									
Current cigarette smokers	1.22	1.52	.09	1.12	3.95	.42	.53	-	.43	1.35	.80	.99	.09	.69	2.60	.87	1.02	.14	1.05	2.12	.60	.71	.09	.65	1.62
2 or more packs	3.91	4.44	.81	4.60	8.91	.80	.94	-	.95	2.15	3.11	3.50	.81	3.65	6.77	1.00	1.01	-	2.60	-	1.00	1.21	-	.87	3.30
Less than 2 packs	1.05	1.33	.05	.90	3.61	.40	.50	-	.40	1.30	.65	.83	.05	.50	2.32	.86	1.02	.15	.96	2.27	.57	.68	.10	.64	1.51
Not current smokers	.86	.75	.04	.39	2.19	.18	.26	-	.18	.73	.56	.48	.04	.21	1.46	.95	.85	.09	.63	2.18	.64	.57	.04	.47	1.43
Work status																									
Working	.87	.83	.10	.59	2.12	.27	.25	-	.25	.57	.60	.58	.10	.34	1.55	1.07	1.01	.10	.93	2.32	.71	.67	.10	.50	1.68
Not now working	1.11	1.21	.04	.80	3.34	.39	.43	-	.31	1.16	.72	.79	.04	.49	2.18	.78	.85	.13	62	2.15	.56	.63	.04	.68	1.33
Worked past 5 yrs	1.11	1.18	-	1.57	2.13	.17	.19	-	.31	.27	.94	.99	-	1.26	1.87	.87	.83	-	.63	2.22	.61	.66	-	.95	1.11
No work past 5 yrs	1.33	1.52	.06	.76	4.52	.55	.63	-	.38	1.83	.78	.88	.06	.38	2.69	.90	1.01	.19	.76	2.45	.61	.70	.06	.66	1.59
Education																									
Elementary school or less	1.48	1.05	.37	.79	2.32	.56	.41	-	.59	.66	.92	.64	.37	.20	1.65	1.42	1.01	.37	.79	2.19	1.17	.76	-	.69	1.85
Some high school	.70	1.06	.34	.48	2.83	.22	.30	-	.13	.94	.48	.76	.34	.35	1.89	.85	1.09	.14	.79	2.79	.50	.63	.10	.53	1.48
Some college	.80	.80	.08	.66	1.93	.18	.18	-	.18	.41	.62	.62	.08	.48	1.52	.73	.71	-	.78	1.56	.47	.46	-	.48	1.04
Relative weight																									
Less than 95	.74	.73	.05	.46	2.00	.24	.23	-	.25	.50	.51	.50	.05	.21	1.50	.56	.55	-	.34	1.60	.41	.40	.05	.25	1.09
95 - 114	1.14	1.19	.06	.78	3.24	.37	.38	-	.33	.94	.78	.81	.06	.45	2.30	1.26	1.30	.06	1.12	3.20	.69	.72	.06	.67	1.64
115+	1.11	1.17	.15	.65	3.24	.35	.37	-	.16	1.16	.76	.80	.15	.49	2.08	1.34	1.41	.45	1.80	2.10	1.11	1.17	.15	.98	2.80
Weight history																									
Less than 10% increase	.64	.83	-	.75	2.01	.35	.43	-	.56	.80	.28	.39	-	.19	1.20	.14	.18	-	.19	.40	.43	.60	-	.19	2.01
10 - 19% increase	.54	.69	-	.55	1.77	.12	.13	-	.18	.22	.43	.56	-	.37	1.55	1.13	1.34	.19	1.30	2.93	.59	.73	-	.65	1.80
20+ % increase	1.30	1.14	.11	.64	3.22	.29	.26	-	.21	.66	1.00	.88	.11	.43	2.56	1.63	1.46	.21	1.22	3.47	1.10	.98	.11	.93	2.22
Age at maximum weight ≤ age at minimum weight	1.26	1.23	.19	.91	3.05	.36	.35	-	.18	1.06	.90	.88	.19	.73	2.00	1.00	.97	.09	.64	2.63	.60	.58	.19	.36	1.43

Series N—numerators (Tables N1-N8)

Frequencies in these tables represent all persons in the participating medical groups, aged 35-64 and insured in HIP for at least two years, who met the study criteria for the given CHD manifestation for the first time in the three years November 1, 1961-October 31, 1964. Criteria for these CHD manifestations are given in detail in Appendix A. Summary definitions appear in section II of the text.

Series D—denominators (Tables D1-D7)

Frequencies in these tables represent respondents to the mail surveys of 1962, 1963, and 1964 who were at risk for a first myocardial infarction. To compute average annual incidence rates the tabulated frequency must be multiplied by 30, the blow-up factor for sampling and nonresponse. Persons not classified as to a given characteristic are shown in these tables; in some circumstances, discussed in Appendix C, these "unknowns" have been distributed before computation of incidence rates. The population at risk for angina or for possible MI is only slightly smaller than that shown in the D tables: for males the total is 3,829, compared with 3,928 at risk for MI; for females the total is 4,273, compared with 4,301 at risk for MI. Exact frequencies for the population at risk for angina and possible MI are available upon request to the authors.

Table N1—Specified manifestations of CHD diagnosed in men, by age and smoking habits

	Definite myocardial infarction												Angina				Possible MI			
	Total				Dead within 48 hrs				Other											
	All ages	35-44	45-54	55-64	All ages	35-44	45-54	55-64	All ages	35-44	45-54	55-64	All ages	35-44	45-54	55-64	All ages	35-44	45-54	55-64
Total	613	59	234	320	199	13	68	118	414	46	166	202	233	19	86	128	137	10	45	82
Current cigarette smokers	332	40	144	148	100	9	40	51	232	31	104	97	128	15	47	66	66	9	24	33
2 or more packs	125	22	52	51	33	4	9	20	92	18	43	31	39	6	11	22	24	3	9	12
Less than 2 packs	207	18	92	97	67	5	31	31	140	13	61	66	89	9	36	44	42	6	15	21
1 or $1\frac{1}{2}$ packs	157	16	72	69	46	5	20	21	111	11	52	48	60	7	27	26	25	4	10	11
Less than 1 pack	50	2	20	28	21	-	11	10	29	2	9	18	29	2	9	18	17	2	5	10
Current pipe/cigar smokers	78	7	34	37	16	1	6	9	62	6	28	28	33	1	11	21	19	1	3	15
Smoked cigarettes in past 5 yrs	13	3	4	6	2	-	1	1	11	3	3	5	1	-	1	-	2	-	1	1
Other	65	4	30	31	14	1	5	8	51	3	25	23	32	1	10	21	17	1	2	14
Not current smokers	165	11	44	110	55	2	12	41	110	9	32	69	70	3	28	39	49	-	17	32
Smoked cigarettes in past 5 yrs	29	4	6	19	13	2	1	10	16	2	5	9	12	1	4	7	12	-	2	10
Other smoking history	57	1	14	42	22	-	6	16	35	1	8	26	28	-	8	20	17	-	4	13
Never smoked	79	6	24	49	20	-	5	15	59	6	19	34	30	2	16	12	20	-	11	9
Smoking habits unknown	38	1	12	25	28	1	10	17	10	-	2	8	2	-	-	2	3	-	1	2

Table N2—Specified manifestations of CHD diagnosed in men, by age and physical activity (PA) class

	Definite myocardial infarction												Angina				Possible MI			
	Total				Dead within 48 hrs				Other											
	All ages	35-44	45-54	55-64	All ages	35-44	45-54	55-64	All ages	35-44	45-54	55-64	All ages	35-44	45-54	55-64	All ages	35-44	45-54	55-64
Total	613	59	234	320	199	13	68	118	414	46	166	202	233	19	86	128	137	10	45	82
Total, PA class applicable*	581	58	224	299	175	12	60	103	406	46	164	196	233	19	86	128	135	10	44	81
Overall PA class (PAx)																				
Least active	181	17	62	102	77	6	26	45	104	11	36	57	49	3	15	31	35	-	9	26
Intermediate	189	15	81	93	44	1	14	29	145	14	67	64	98	10	32	56	55	5	18	32
Most active	169	25	65	79	30	4	12	14	139	21	53	65	80	6	36	38	42	5	16	21
Not classified	42	1	16	25	24	1	8	15	18	-	8	10	6	-	3	3	3	-	1	2
Alternative overall PA class (PAx')																				
Least active	229	19	81	129	94	6	31	57	135	13	50	72	65	3	21	41	44	-	11	33
1st intermediate	76	9	19	48	23	3	5	15	53	6	14	33	51	6	15	30	23	1	7	15
2nd intermediate	161	23	72	66	27	2	13	12	134	21	59	54	71	6	29	36	44	5	19	20
Most active	70	6	34	30	5	-	2	3	65	6	32	27	39	4	18	17	20	4	6	10
Not classified	45	1	18	26	26	1	9	16	19	-	9	10	7	-	3	4	4	-	1	3
Job-connected PA (PAj)																				
Least active	246	25	102	119	80	7	31	42	166	18	71	77	76	6	25	45	58	4	18	36
1st intermediate	151	17	56	78	42	1	14	27	109	16	42	51	66	3	28	35	32	1	12	19
2nd intermediate	85	10	38	37	14	1	4	9	71	9	34	28	55	7	19	29	28	3	8	17
Most active	65	5	17	43	15	2	3	10	50	3	14	33	36	3	14	19	15	2	5	8
Not classified	34	1	11	22	24	1	8	15	10	-	3	7	-				2	-	1	1
Off-job PA (PAoj)																				
Least active	145	10	46	89	65	4	20	41	80	6	26	48	41	3	12	26	34	-	8	26
1st intermediate	188	18	62	108	72	5	22	45	116	13	40	63	75	6	24	45	34	1	11	22
2nd intermediate	117	9	54	54	19	1	6	12	98	8	48	42	60	7	21	32	34	4	14	16
Most active	118	21	54	43	16	2	10	4	102	19	44	39	50	3	26	21	32	5	11	16
Not classified	45	1	18	26	27	1	10	16	18	-	8	10	7	-	3	4	3	-	1	2

* The classification of *over-all* and of *job-connected* physical activity is applicable only to those men known to have been employed within the five years preceding diagnosis of the given CHD manifestation. Men "not classified" in these respects are those who worked within this time period for whom insufficient information was available to classify the given type of physical activity.

Table N3—Specified manifestations of CHD diagnosed in men without prior CHD and without prior limitation of physical activity, by age and over-all physical activity class

	Definite myocardial infarction												Angina				Possible MI			
	Total				Dead within 48 hrs				Other											
	All ages	35-44	45-54	55-64	All ages	35-44	45-54	55-64	All ages	35-44	45-54	55-64	All ages	35-44	45-54	55-64	All ages	35-44	45-54	55-64
No prior CHD																				
Total, PA class applicable*	447	53	179	215	119	11	43	65	328	42	136	150	214	18	79	117	97	8	36	53
Least active	128	16	48	64	51	5	20	26	77	11	28	38	44	3	14	27	19	-	6	13
Intermediate	156	13	70	73	33	1	11	21	123	12	59	52	89	10	29	50	39	4	14	21
Most active	138	23	50	65	22	4	8	10	116	19	42	55	75	5	33	37	37	4	15	18
Not classified	25	1	11	13	13	1	4	8	12	-	7	5	6	-	3	3	2	-	1	1
No prior limitation of physical activity																				
Total, PA class applicable*	474	49	181	244	133	11	44	78	341	38	137	166	206	19	75	112	117	10	40	67
Least active	137	13	45	79	54	5	18	31	83	8	27	48	37	3	11	23	25	-	7	18
Intermediate	158	12	68	78	41	1	12	28	117	11	56	50	89	10	29	50	50	5	17	28
Most active	150	23	56	71	24	4	9	11	126	19	47	60	75	6	33	36	40	5	15	20
Not classified	29	1	12	16	14	1	5	8	15	-	7	8	5	-	2	3	2	-	1	1

* See corresponding footnote, Table N2.

Table N4—Specified manifestations of CHD diagnosed in men, by age and demographic characteristics: color, religion, place of birth, and marital status

	Definite myocardial infarction												Angina				Possible MI			
	Total				Dead within 48 hrs				Other											
	All ages	35-44	45-54	55-64	All ages	35-44	45-54	55-64	All ages	35-44	45-54	55-64	All ages	35-44	45-54	55-64	All ages	35-44	45-54	55-64
Total	613	59	234	320	199	13	68	118	414	46	166	202	233	19	86	128	137	10	45	82
Color																				
White	570	55	215	300	176	11	58	107	394	44	157	193	220	17	82	121	126	7	42	77
Nonwhite	25	4	12	9	12	2	5	5	13	2	7	4	12	2	4	6	11	3	3	5
Not answered	18	-	7	11	11	-	5	6	7	-	2	5	1	-	-	1	-			
Religion																				
Protestant	72	9	26	37	28	3	8	17	44	6	18	20	27	3	8	16	15	2	5	8
Catholic	215	26	87	102	80	6	25	49	135	20	62	53	92	11	37	44	53	7	17	29
Jewish	286	22	107	157	68	3	25	40	218	19	82	117	110	5	40	65	63	-	20	43
Other or none	6	1	4	1	2	-	2	-	4	1	2	1	4	-	1	3	5	1	2	2
Not answered	34	1	10	23	21	1	8	12	13	-	2	11	-				1	-	1	-
Place of birth																				
Continental U.S.	441	51	187	203	141	10	54	77	300	41	133	126	170	19	73	78	97	10	34	53
Europe*	142	6	35	101	46	2	11	33	96	4	24	68	59	-	12	47	33	-	8	25
Western Europe	49	1	13	35	13	1	3	9	36	-	10	26	19	-	4	15	7	-	1	6
Southern Europe	23	1	7	15	10	-	3	7	13	1	4	8	9	-	1	8	4	-	1	3
Eastern Europe	70	4	15	51	23	1	5	17	47	3	10	34	31	-	7	24	22	-	6	16
Other known	23	2	9	12	11	1	3	7	12	1	6	5	4	-	1	3	7	-	3	4
Not answered	7	-	3	4	1	-	-	1	6	-	3	3	-				-			
Marital status																				
Married	523	48	198	277	169	11	57	101	354	37	141	176	210	15	79	116	129	9	42	78
Other than married	60	7	24	29	23	1	8	14	37	6	16	15	23	4	7	12	8	1	3	4
Not answered	30	4	12	14	7	1	3	3	23	3	9	11	-				-			

* Excluding Scandinavian countries.

Table N5—Specified manifestations of CHD diagnosed in men, by age and demographic characteristics: education and occupation

	Definite myocardial infarction												Angina				Possible MI			
	Total				Dead within 48 hrs				Other											
	All ages	35-44	45-54	55-64	All ages	35-44	45-54	55-64	All ages	35-44	45-54	55-64	All ages	35-44	45-54	55-64	All ages	35-44	45-54	55-64
Total	613	59	234	320	199	13	68	118	414	46	166	202	233	19	86	128	137	10	45	82
Education																				
Elementary school or less	148	2	46	100	46	-	17	29	102	2	29	71	74	2	19	53	37	1	10	26
Some high school	226	36	93	97	63	7	20	36	163	29	73	61	76	13	36	27	53	6	14	33
Some college	197	20	78	99	59	5	17	37	138	15	61	62	82	4	31	47	45	3	20	22
Not answered	42	1	17	24	31	1	14	16	11	-	3	8	1	-	-	1	2	-	1	1
Total working or worked in past 5 yrs	581	58	224	299	175	12	60	103	406	46	164	196	233	19	86	128	135	10	44	81
Occupation																				
White collar	298	27	116	155	85	5	26	54	213	22	90	101	109	5	35	69	66	1	23	42
Professional, technical	137	15	44	78	35	2	8	25	102	13	36	53	44	3	16	25	23	-	11	12
Managers, officials	60	5	31	24	15	2	8	5	45	3	23	19	25	-	8	17	13	-	4	9
Clerical and sales	101	7	41	53	35	1	10	24	66	6	31	29	40	2	11	27	30	1	8	21
Blue collar	281	31	108	142	89	7	34	48	192	24	74	94	124	14	51	59	69	9	21	39
Craftsmen, foremen	100	6	35	59	31	2	9	20	69	4	26	39	42	6	17	19	24	1	8	15
Operatives	96	12	36	48	33	2	14	17	63	10	22	31	47	4	19	24	23	4	5	14
Service and laborers	85	13	37	35	25	3	11	11	60	10	26	24	35	4	15	16	22	4	8	10
Not answered	2	-	-	2	1	-	-	1	1	-	-	1	-				-			

Table N6—Specified manifestations of CHD diagnosed in men, by age, relative weight, and weight history since age 25

	Definite myocardial infarction												Angina				Possible MI			
	Total				Dead within 48 hrs				Other											
	All ages	35-44	45-54	55-64	All ages	35-44	45-54	55-64	All ages	35-44	45-54	55-64	All ages	35-44	45-54	55-64	All ages	35-44	45-54	55-64
Total	613	59	234	320	199	13	68	118	414	46	166	202	233	19	86	128	137	10	45	82
Relative weight																				
Under 95	146	8	50	88	53	1	17	35	93	7	33	53	55	3	15	37	34	3	11	20
95-114	315	35	114	166	95	7	28	60	220	28	86	106	125	11	51	63	70	4	19	47
115+	103	14	51	38	24	3	12	9	79	11	39	29	44	5	15	24	28	2	12	14
Not classified	49	2	19	28	27	2	11	14	22	-	8	14	9	-	5	4	5	1	3	1
Weight history since age 25																				
Less than 10% increase	48	10	15	23	13	2	3	8	35	8	12	15	19	2	7	10	10	1	2	7
10-19% increase	109	15	32	62	33	5	5	23	76	10	27	39	58	6	22	30	34	3	8	23
20+ % increase	218	14	93	111	55	1	24	30	163	13	69	81	95	7	37	51	58	3	21	34
Age at maximum weight ≮ age at minimum weight	132	14	58	60	52	5	20	27	80	9	38	33	54	2	18	34	31	3	13	15
Not classified	106	6	36	64	46	-	16	30	60	6	20	34	7	2	2	3	4	-	1	3
Relative weight and weight history																				
Relative weight under 115																				
Less than 10% increase	44	9	13	22	13	2	3	8	31	7	10	14	17	1	7	9	9	1	1	7
10-19% increase	95	10	28	57	28	2	5	21	67	8	23	36	50	6	17	27	28	1	6	21
20+ % increase	145	10	54	81	42	1	15	26	103	9	39	55	66	4	27	35	40	2	14	24
Age at maximum weight ≮ age at minimum weight	95	11	40	44	30	3	11	16	65	8	29	28	43	1	14	28	24	3	8	11
Relative weight 115+																				
Less than 10% increase	3	1	1	1	-				3	1	1	1	2	1	-	1	1	-	1	-
10-19% increase	14	5	4	5	5	3	-	2	9	2	4	3	7	-	4	3	5	2	1	2
20+ % increase	67	4	36	27	13	-	9	4	54	4	27	23	26	3	9	14	17	-	7	10
Age at maximum weight ≮ age at minimum weight	9	1	7	1	2	-	1	1	7	1	6	-	8	1	2	5	5	-	3	2

Table N7—Specified manifestations of CHD diagnosed in women, by age and demographic characteristics: color, religion, place of birth, and marital status

	Definite myocardial infarction												Angina				Possible MI			
	Total				Dead within 48 hrs				Other											
	All ages	35-44	45-54	55-64	All ages	35-44	45-54	55-64	All ages	35-44	45-54	55-64	All ages	35-44	45-54	55-64	All ages	35-44	45-54	55-64
Total	129	3	34	92	45	-	14	31	84	3	20	61	118	5	40	73	80	3	27	50
Color																				
White	116	2	27	87	40	-	12	28	76	2	15	59	109	4	37	68	75	3	24	48
Nonwhite	7	1	4	2	1	-	1	-	6	1	3	2	9	1	3	5	5	-	3	2
Not answered	6	-	3	3	4	-	1	3	2	-	2	-	-				-			
Religion																				
Protestant	17	1	7	9	8	-	4	4	9	1	3	5	13	1	4	8	11	-	5	6
Catholic	41	2	11	28	18	-	6	12	23	2	5	16	39	2	15	22	38	3	12	23
Jewish	58	-	13	45	11	-	3	8	47	-	10	37	64	2	21	41	29	-	9	20
Other or none	3	-	-	3	1	-	-	1	2	-	-	2	2	-	-	2	2	-	1	1
Not answered	10	-	3	7	7	-	1	6	3	-	2	1	-				-			
Place of birth																				
Continental U.S.	79	3	24	52	23	-	10	13	56	3	14	39	75	4	31	40	54	3	22	29
Europe*	46	-	7	39	22	-	4	18	24	-	3	21	37	1	8	28	22	-	4	18
Western Europe	14	-	3	11	4	-	1	3	10	-	2	8	10	-	1	9	3	-	1	2
Southern Europe	6	-	1	5	3	-	-	3	3	-	1	2	7	-	2	5	6	-	-	6
Eastern Europe	26	-	3	23	15	-	3	12	11	-	-	11	20	1	5	14	13	-	3	10
Other known	3	-	2	1	-				3	-	1	2	6	-	1	5	4	-	1	3
Not answered	1	-	1	-	-				1	-	1	-	-				-			
Marital status																				
Married	86	3	28	55	28	-	12	16	58	3	16	39	81	5	31	45	58	3	24	31
Other than married	38	-	4	34	16	-	2	14	22	-	2	20	37	-	9	28	21	-	3	18
Not answered	5	-	2	3	1	-	-	1	4	-	2	2	-				1	-	-	1

* Excluding Scandinavian countries.

Table N8—Specified manifestations of CHD diagnosed in women, by age and selected personal characteristics: smoking habits, work status, education, relative weight, and weight history since age 25

	Definite myocardial infarction												Angina				Possible MI			
	Total				Dead within 48 hrs				Other											
	All ages	35-44	45-54	55-64	All ages	35-44	45-54	55-64	All ages	35-44	45-54	55-64	All ages	35-44	45-54	55-64	All ages	35-44	45-54	55-64
Total	129	3	34	92	45	-	14	31	84	3	20	61	118	5	40	73	80	3	27	50
Smoking habits																				
Current cigarette smokers	57	2	21	34	18	-	8	10	39	2	13	24	44	3	21	20	30	2	13	15
2 or more packs	11	1	5	5	2	-	1	1	9	1	4	4	3	-	3	-	3	-	1	2
Less than 2 packs	46	1	16	29	16	-	7	9	30	1	9	20	41	3	18	20	27	2	12	13
Not current smokers	61	1	11	49	19	-	5	14	42	1	6	35	74	2	19	53	49	1	14	34
Smoking habits unknown	11	-	2	9	8	-	1	7	3	-	1	2	-				1	-	-	1
Work status																				
Working	62	2	19	41	19	-	8	11	43	2	11	30	76	2	30	44	50	2	16	32
Not now working	60	1	13	46	21	-	5	16	39	1	8	30	42	3	10	29	30	1	11	18
Worked past 5 years	13	-	5	8	2	-	1	1	11	-	4	7	10	-	2	8	7	-	3	4
No work past 5 years	46	1	8	37	19	-	4	15	27	1	4	22	31	3	8	20	21	1	7	13
5 year status unknown	1	-	-	1	-				1	-	-	1	1	-	-	1	2	-	1	1
Work status unknown	7	-	2	5	5	-	1	4	2	-	1	1	-				-			
Education																				
Elementary school or less	37	1	8	28	14	-	6	8	23	1	2	20	35	1	8	26	29	-	7	22
Some high school	45	1	11	33	14	-	3	11	31	1	8	22	54	4	18	32	32	3	12	17
Some college	31	1	11	19	7	-	3	4	24	1	8	15	28	-	13	15	18	-	8	10
Not answered	16	-	4	12	10	-	2	8	6	-	2	4	1	-	1	-	1	-	-	1
Relative weight																				
Under 95	44	1	11	32	14	-	6	8	30	1	5	24	33	-	8	25	24	1	6	17
95-114	53	1	14	38	17	-	6	11	36	1	8	27	58	1	20	37	32	1	12	19
115+	19	1	4	14	6	-	1	5	13	1	3	9	23	3	11	9	19	1	6	12
Not classified	13	-	5	8	8	-	1	7	5	-	4	1	4	1	1	2	5	-	3	2
Weight history since age 25																				
Less than 10% increase	9	-	4	5	5	-	3	2	4	-	1	3	2	-	1	1	6	-	1	5
10-19% increase	14	-	6	8	3	-	2	1	11	-	4	7	29	2	14	13	15	-	7	8
20+ % increase	44	1	9	34	10	-	3	7	34	1	6	27	55	2	17	36	37	1	13	23
Age at maximum weight ≤ age at minimum weight	38	2	10	26	11	-	2	9	27	2	8	17	30	1	7	22	18	2	4	12
Not classified	24	-	5	19	16	-	4	12	8	-	1	7	2	-	1	1	4	-	2	2

Table D1—Males at risk for first MI, by age and smoking habits

	All ages	35-44	45-54	55-64
Total	3928	1383	1409	1136
Current cigarette smokers	1734	709	609	416
2 or more packs	227	95	86	46
Less than 2 packs	1507	614	523	370
1 or $1\frac{1}{2}$ packs	1119	452	398	269
Less than 1 pack	388	162	125	101
Current pipe/cigar smokers	429	133	163	133
Smoked cigarettes in past 5 yrs	60	23	26	11
Other	369	110	137	122
Not current smokers	1573	479	569	525
Smoked cigarettes in past 5 yrs	342	120	119	103
Other smoking history	530	113	205	212
Never smoked	701	246	245	210
Smoking habits unknown	192	62	68	62

Table D2—Males at risk for first MI, by age and physical activity (PA) class

	All ages	35-44	45-54	55-64
Total	3928	1383	1409	1136
Total, PA class applicable*	3826	1351	1386	1089
Overall PA class (PAx)				
Least active	614	174	242	198
Intermediate	1383	491	498	394
Most active	1375	587	491	297
Not classified	454	99	155	200
Alternative overall PA class (PAx')				
Least active	873	261	327	285
1st intermediate	499	154	169	176
2nd intermediate	1151	466	437	248
Most active	722	339	248	135
Not classified	581	131	205	245
Job-connected PA (PAj)				
Least active	1143	379	441	323
1st intermediate	1057	382	376	299
2nd intermediate	835	322	295	218
Most active	574	213	202	159
Not classified	217	55	72	90
Off-job PA (PAoj)				
Least active	452	121	168	163
1st intermediate	1026	318	358	350
2nd intermediate	1028	389	375	264
Most active	959	464	343	152
Not classified	463	91	165	207

* The classification of *over-all* and of *job-connected* physical activity is applicable only to those men known to have been employed within the five years preceding the given mail survey. Men "not classified" in these respects are those who worked within this time period who furnished insufficient information on the questionnaires to classify the given type of physical activity.

Table D3—Males at risk for first MI, by age and demographic characteristics: color, religion, place of birth, and marital status

	All ages	35-44	45-54	55-64
Total	3928	1383	1409	1136
Color				
White	3469	1183	1252	1034
Nonwhite	378	180	132	66
Not answered	81	20	25	36
Religion				
Protestant	582	209	201	172
Catholic	1778	729	588	461
Jewish	1370	369	550	451
Other or none	161	61	57	43
Not answered	37	15	13	9
Place of birth				
Continental U.S.	3025	1202	1193	630
Europe*	610	82	127	401
Western Europe	226	27	43	156
Southern Europe	134	32	18	84
Eastern Europe	250	23	66	161
Other known	189	71	52	66
Not answered	104	28	37	39
Marital status				
Married	3437	1215	1239	983
Other than married	473	165	165	143
Not answered	18	3	5	10

* Excluding Scandinavian countries.

Table D4—Males at risk for first MI, by age and demographic characteristics: education and occupation

	All ages	35-44	45-54	55-64
Total	3928	1383	1409	1136
Education				
Elementary school or less	803	82	273	448
Some high school	1677	790	573	314
Some college	1416	503	554	359
Not answered	32	8	9	15
Total working or worked in past 5 yrs	3826	1351	1386	1089
Occupation				
White collar	1675	514	674	487
Professional, technical	845	285	296	264
Managers, officials	327	91	151	85
Clerical and sales	503	138	227	138
Blue collar	1954	784	642	528
Craftsmen, foremen	572	167	208	197
Operatives	538	169	182	187
Service and laborers	844	448	252	144
Not answered	197	53	70	74

Table D5—Males at risk for first MI, by age, relative weight, and weight history since age 25

	All ages	35-44	45-54	55-64
Total	3928	1383	1409	1136
Relative weight				
Under 95	936	275	335	326
95-114	2255	800	848	607
115+	619	279	184	156
Not classified	118	29	42	47
Weight history since age 25				
Less than 10% increase	536	256	139	141
10-19% increase	905	345	359	201
20+ % increase	1052	301	425	326
Age at maximum weight ⩽ age at minimum weight	809	317	283	209
Not classified	626	164	203	259
Relative weight and weight history				
Relative weight under 115				
Less than 10% increase	459	208	124	127
10-19% increase	773	262	333	178
20+ % increase	766	206	324	236
Age at maximum weight < age at minimum weight	702	272	245	185
Relative weight 115+				
Less than 10% increase	67	44	11	12
10-19% increase	109	75	20	14
20+ % increase	265	92	91	82
Age at maximum weight < age at minimum weight	86	42	31	13

Table D6—Females at risk for first MI, by age and demographic characteristics: color, religion, place of birth, and marital status

	All ages	35-44	45-54	55-64
Total	4301	1487	1669	1145
Color				
White	3727	1222	1477	1028
Nonwhite	475	242	151	82
Not answered	99	23	41	35
Religion				
Protestant	695	256	252	187
Catholic	1744	714	629	401
Jewish	1697	450	732	515
Other or none	135	58	43	34
Not answered	30	9	13	8
Place of birth				
Continental U.S.	3311	1303	1326	682
Europe*	696	95	237	364
Western Europe	269	45	90	134
Southern Europe	138	24	55	59
Eastern Europe	289	26	92	171
Other known	192	63	70	59
Not answered	102	26	36	40
Marital status				
Married	3450	1314	1363	773
Other than married	836	173	295	368
Not answered	15	-	11	4

* Excluding Scandinavian countries.

Table D7—Females at risk for first MI, by age and selected personal characteristics: smoking habits, work status, education, relative weight, and weight history since age 25

	All ages	35-44	45-54	55-64
Total	4301	1487	1669	1145
Smoking habits				
Current cigarette smokers	1635	693	642	300
2 or more packs	96	40	37	19
Less than 2 packs	1539	653	605	281
Not current smokers	2504	757	967	780
Smoking habits unknown	162	37	60	65
Work status				
Working	2374	655	1075	644
Not now working	1796	794	543	459
Worked past 5 yrs	391	160	106	125
No work past 5 yrs	1154	529	352	273
5 yr status unknown	251	105	85	61
Work status unknown	131	38	51	42
Education				
Elementary school or less	831	91	337	403
Some high school	2132	984	760	388
Some college	1286	402	556	328
Not answered	52	10	16	26
Relative weight				
Under 95	1974	642	799	533
95-114	1544	555	598	391
115+	572	224	204	144
Not classified	211	66	68	77
Weight history since age 25				
Less than 10% increase	470	210	177	83
10-19% increase	857	345	361	151
20+ % increase	1132	314	466	352
Age at maximum weight $\leqslant$ age at minimum weight	1005	354	367	284
Not classified	837	264	298	275

APPENDIX A
Criteria for Diagnosis

Myocardial Infarction and Possible Myocardial Infarction

Rates presented in this report for "definite MI" are based on all patients who (a) met the study criteria for "highly probable" or "probable" MI or (b) fulfilled the study definition of a "new coronary event leading to death" (NCE)* for the first time in the three years November 1, 1961-October 31, 1964. Subdivisions of the definite MI rates are presented throughout the report for those rapidly fatal (deaths within 48 hours) and all others. Rates for "possible MI" are based on all patients who met the study criteria for this manifestation for the first time in the three years of case finding except those who also sustained a diagnosis of angina within two months of the episode classified as a possible MI. Patients who within a two-month period met study criteria for both angina and possible MI are counted only in the numerators of the angina incidence rates.

The criteria for classification of myocardial infarction as "highly probable," "probable," or "possible" are structured from specified combinations of the findings in three areas: (1) ECG abnormalities; (2) "acute phase" phenomena; and (3) symptomatology.

(1) *ECG Abnormalities* — Detailed descriptions of four sets of abnormal ECG patterns are presented as Table AA1. In general, these sets may be characterized as follows:

Series A—patterns highly specific for the diagnosis of MI, recent or old

Series B—patterns common in and suggestive of MI, although less specific than those in Series A

Series C—patterns frequently encountered in patients with CHD, although not in themselves diagnostic of MI

Series D—certain conduction defects.

* Excluded from the NCE category are patients with a prior diagnosis of highly probable or probable MI.

Other abnormalities, not listed in the table, are referred to as "nonspecified." The diagnosis of highly probable or probable MI requires an ECG abnormality of a type specified in Table AA1.

The electrocardiogram in this study is not used to screen a population in order to identify patients with CHD. It is, rather, a part of the whole clinical record available for diagnosis. Each such record contains the tracing obtained at the baseline examination; descriptions of the findings on ECGs taken under HIP medical care before this date are available for practically all evaluated patients, and, if necessary, copies of these earlier records were obtained. Abstracts of hospital records provide for descriptions of the tracings and here too verifaxed copies were obtained when necessary.

The descriptions of abnormal patterns listed as Table AA1 were developed by working with clinical material both from the study patients and an independent series of hospital records. All ECGs of patients being followed for prognosis are classified both by the study's electrocardiographer and the medical director; differences in classification are discussed and resolved.

When reference is made to ECG abnormalities in connection with a diagnosis of MI or possible MI, it is understood that the ECG finding in question was not known to have been present before the time of this diagnosis. In the presence of conditions other than CHD which may produce any of the specified abnormalities, the ECG findings are assigned less weight in making the diagnosis. These conditions, and the mechanism for taking their presence into consideration, are presented as Tables AA2 and AA3.

(2) *"Acute Phase" Phenomena*—Decision on the presence of a positive "acute phase" is made after full review

of all clinical records from examination of four different measurements made at the time of a suspected episode of MI:SGOT, temperature record, erythrocyte sedimentation rate, and white blood count. Limits of abnormality are defined for each of these components in Table AA4. A positive acute phase is considered present if any one of the following conditions is met and there is no other disease to account for the abnormalities:

(a) SGOT is 55 or more
(b) SGOT is 40-54, and there is one other acute phase abnormality, as defined
(c) SGOT is under 40 or not known but there are at least two other acute phase abnormalities.

(3) *Symptomatology*—The subjective complaints of a patient at the time of a possible coronary event are reviewed first to determine whether any diagnosis other than CHD can be made. If it is accepted that no other condition can reasonably account for the symptoms, then the character of the patient's complaint is considered in deciding the certainty with which the diagnosis of MI is to be made. Provision is made for two "symptom patterns," described in Table AA5. The first ("symptom pattern I") describes the so-called "classic" pain pattern of myocardial infarction, while "symptom pattern II" is broader in scope.

Findings in the three areas described —ECGs, acute phase phenomena, and symptomatology—are assessed in relation to the defined limits of abnormality by the study's medical director. Once this assessment is made, the study criteria stipulate classification of the MI through the combinations of findings outlined in Table A1. Patients who satisfy the criteria for a possible MI but who later in the same acute illness satisfy the criteria for highly probable or probable MI or NCE are classified only in the latter categories.

The general distribution of all first MIs diagnosed in the three years of case finding and contributing to incidence of "definite MI" was as follows:

	Males		Females	
	No.	%	No.	%
Definite MI	613	100.0	129	100.0
"Highly probable"	349	56.9	65	50.4
"Probable"	84	13.7	23	17.8
New coronary events leading to death	180	29.4	41	31.8

Detailed distributions in relation to the criteria fulfilled are shown for the first MIs not fatal within 48 hours in Table A2, and for the rapidly fatal group in Table A3. Of those dying within 48 hours of the event, over 60 per cent of the men and over 55 per cent of the women either met the study ECG and clinical criteria for highly probable MI or the deaths were observed to occur within a few minutes of the deceased's usual state of health (Table A3). Of the definite MIs which were not fatal within 48 hours, 80 per cent of the men and 73 per cent of the women met the study criteria for highly probable MI (Table A2). Over 90 per cent of these patients exhibited Series A or Series B ECGs.

Distribution by detailed criteria fulfilled for possible MI is shown for the cases entering into the numerators of the incidence rates in Table A4.

Angina Pectoris

All persons who had never met the study criteria for MI (highly probable or probable) and who were free of aortic valvular disease were considered to be at risk for a first diagnosis of angina. A diagnosis of angina was made only for patients who had the baseline examination, during which the study's examining physician recorded the details of any complaint of chest pain on a highly structured form. To achieve the greatest possible consistency in deciding on borderline histories a scoring system, described in Table AA6, was applied to all evaluated patients. A net score exceeding 10 was required for a diagnosis of "definite" angina—the cases counted in the numerators presented in this report. Only those symptom patterns described as occurring over a period of two months or more were classified as angina, provided the scoring requirements were met. The two-month requirement was adopted in order for a reasonable time to have elapsed to establish the usual precipitants, duration, and pattern of response to rest and drugs, and in order to avoid including in the angina cohort both patients with preinfarction prodromes and those with spontaneous remissions after one or two episodes. It is to be noted that the final decision to classify a patient as new angina was made centrally by the study's medical director on the basis of the scored chest pain history recorded at the baseline examination; the decision was made solely from the evaluation of the history, without relation to the ECG findings at rest or after exercise, to the coexistence of any other evidence of CHD, or to the expressed opinion of the examining physician.

Table A1—Outline of criteria for diagnosis of myocardial infarction

Highly probable (Code 2)
Probable (Code 3)
Possible (Code 5)

Symptom pattern	Acute phase reaction	Specified ECG abnormality					Non-specified abnormality	ECG normal
		Series A	Series B	L. BBB (D1)	Series C	Series D (except D1)		
I	Yes	2	2	2	3	3	5	(5)*
II	Yes	2	3	3	3	5	5	
None	Yes	2	3	3	5	5	5	
I	No	2	3	3	5	5	5	(5)*
II	No	2	5	5	5	5	5	
None	No	2	5	(5)†				

NOTE: In the presence of a condition considered an "exclusion" against the usual inference to be made from the ECG findings (see Table AA2), the procedure is to give abnormalities in Series A the weight of Series B findings, those in Series B the weight of Series C findings, and those in Series C or Series D the weight of nonspecified abnormalities. Nonspecified abnormalities in the presence of excluding conditions are equated to normal ECGs.

( )*Restricted to patients for whom definite angina has been diagnosed.

( )†Restricted to patients for whom the ECG finding of left bundle branch block is known *not* to have been present before.

Table A2—First MIs not fatal within 48 hours, by criteria fulfilled for diagnosis, each sex (first MIs diagnosed in the three years November 1, 1961-October 31, 1964)

	ECG series	Acute phase	Symptom pattern	Males No.	Males %	Females No.	Females %
Total definite MI, not rapidly fatal				414	100.0	84	100.0
Highly probable				330	79.7	61	72.6
	A	+	I	177	42.8	28	33.3
	A	+	II	12	2.9	1	1.2
	A	+	-	6	1.4	4	4.8
	A	-	I	35	8.5	9	10.7
	A	-	II	25	6.0	-	
	A	-	-	25	6.0	3	3.6
	B or D1	+	I	50	12.1	16	19.0
Probable				84	20.3	23	27.4
	B	+	II	12	2.9	3	3.6
	B or D1	+	-	6	1.4	1	1.2
	B or D1	-	I	28	6.8	10	11.9
	C	+	I	34	8.2	8	9.5
	C	+	II	2	0.5	-	
	D exc. D1	+	I	2	0.5	1	1.2

Table A3—First MIs leading to death within 48 hours, by criteria fulfilled for diagnosis, each sex (first MIs diagnosed in the three years November 1, 1961-October 31, 1964)

	Males No.	Males %	Females No.	Females %
Total definite MI, rapidly fatal	199	100.0	45	100.0
Highly probable MI	19	9.5	4	8.9
ECG series / Acute phase / Symptom pattern				
A + I	5		1	
A - I	11		2	
A - II	2		-	
A - -	1		-	
B + I	-		1	
New coronary events leading to death (NCE)*	180	90.5	41	91.1
Death observed to occur within a few minutes of deceased's usual state of health	102	51.3	21	46.7
Chest pain (usually 'symptom pattern I') within 24 hours preceding death	32	16.1	8	17.8
Prior possible MI or angina, usually first diagnosed within 2 months preceding death	20	10.1	5	11.1
Post mortem diagnosis of recent MI or coronary occlusion	4	2.0	1	2.2
Deaths of known hypertensives, other possible causes reasonably excluded	19	9.5	5	11.1
Deaths under medical observation, other possible causes reasonably excluded	3	1.5	1	2.2

* The six categories listed below this heading are mutually exclusive, patients being assigned to the first group for which the definition is met, in the order listed.

Table A4—Possible MIs, by criteria fulfilled for diagnosis, each sex (first possible MIs diagnosed in the three years November 1, 1961-October 31, 1964, persons without a diagnosis of angina within two months of the possible MI date)

			Males		Females	
			No.	%	No.	%
Total possible MI			137	100.0	80	100.0
ECG	Acute phase	Symptom pattern				
Series B			51	37.2	27	33.7
	-	II	14		12	
	-	-	37		15	
L.BBB (D1)			7	5.1	10	12.5
	-	II	-		1	
	-	-	7		9	
Series C			27	19.7	14	17.5
	+	-	4		-	
	-	I	14		8	
	-	II	9		6	
Series D (~~exc. D1~~)			6	4.4		
	+	II	1			
	-	I	1			
	-	II	4			
Non-specified abnormality			34	24.8	22	27.5
	+	I	11		7	
	+	II	3		1	
	+	-	-		2	
	-	I	8		4	
	-	II	12		8	
Normal			12	8.8	7	8.8
	+	I	2		-	
	-	I	10		7	

Table AA1—List of specified ECG abnormalities

Note: All references to Q waves in the descriptions which follow are understood to specify a width of 0.03 sec or wider unless otherwise stated. When the magnitude of ST segment elevation or depression is specified, the measurement is to be made with respect to the previous PR segment.

Series A

A1. Q wave greater than 20% of R associated with inverted or biphasic T waves in any of leads 1, V5 or V6, or with ST segment elevation (upward convexity) of 3 mm or more at its highest point in any one of these leads, or with similar shaped ST segment but with terminal dipping in any one of these leads.

A2. *In the absence of* (a) a tall R wave (greater than 20 mm) with ST segment depression and T wave inversion in leads 1, AVL or AVF and
(b) a tall R wave (greater than 25 mm) with ST segment depression and T wave inversion in leads V5 or V6:
- (1) Q waves are present in leads 2, AVF and 3. (An initial upward deflection of no more than 0.25 mm is permissible in lead 3.) Either the Q in lead 2 is 20% or more of R in that lead, or the Q in AVF is 50% or more of R in AVF.
- (2) In addition at least one of the following abnormalities must be present:
  - (i) T waves inverted or biphasic in all three leads, or
  - (ii) ST segment elevation (upward convexity) of 3 mm or more at its highest point in any one of these leads, or
  - (iii) Similar shaped ST segment with terminal dipping in all three of these leads.

A3. (1) Q waves greater than 20% of R are present in leads V2, V3 and V4.
- (2) In addition at least one of the following abnormalities must be present:
  - (i) Inverted or biphasic T waves in all three leads, and QRS is less than 0.12 sec; or
  - (ii) ST segment elevation (upward convexity) of 3 mm or more at its highest point in any one of the leads, and left bundle branch block is not present; or
  - (iii) Similar shaped ST segment with terminal dipping in lead V3 or V4 in the absence of left bundle branch block.

A4. (1) QS deflection (with or without notching at the beginning) with ST segment elevation (upward convexity) is present in leads V2 and V3, and QRS is less than 0.11 sec.
- (2) In addition *either* of the following abnormalities must be present:
  - (i) Inverted or biphasic T in V4.
  - (ii) ST segment elevation (upward convexity) in leads V2, V3 and V4, with either a 3 mm elevation at its highest point in any one of these leads or terminal dipping in all three leads.

A5. A series of three records within a time interval of one month demonstrating the evolutionary changes of ST segment displacement, followed by developing or deepening Q waves in association with ST segment displacement and inverted or biphasic T waves. These changes may be observed in any of the following leads: 1, 2, AVF, V3, V4, V5 or V6.

Series B

B1. Requirements for A1 are fulfilled except that the downward deflection at the beginning of the QRS is preceded by an initial upward deflection of no greater than 0.25 mm.

B2. Requirements for A2 are fulfilled with the same exception noted under B1 with reference to leads 2 and AVF.

B3. Requirements for A3 are fulfilled with the same exception noted under B1.

B4. (1) In lead AVF there is Q wave greater than 50% of R and associated with elevated ST segment and inverted or biphasic T wave; or,
- (2) Q waves are present in leads 2, 3 and AVF associated with *one* of the following abnormalities:
  - (i) Inverted or biphasic T waves in all three of these leads.
  - (ii) ST segment elevation (upward convexity) of 3 mm or more at its highest point in any of these leads
  - (iii) Similar shaped ST segment but with terminal dipping in any of these leads.

B5. QS deflection in leads V2 and V3, associated with ST segment elevation and inverted or biphasic T waves in these leads. QRS does not exceed 0.11 sec.

B6. Q wave 0.04 sec or wider and greater than 15% of R is associated with flat or inverted T waves in any of the following leads: 1, 2, V4, V5 or V6.

B7. The development of Q waves in association with biphasic or inverted T waves in any of the leads 1, 2, V3, V4, V5 or V6 with known normal QRS–T pattern previously present.

Table AA1—(Continued)

B8. Right bundle branch block with T wave inverted or biphasic in any two of the following leads: 1, 2, AVF, V4, V5, V6.

B9. Horizontal ST segment depression 3 mm or more and inverted or biphasic T waves in at least two of the leads V3 through V6. Heart rate does not exceed 120. The sum of S in V1 and R in V5 is less than 35 mm.

B10. Upward displacement and upward convexity of ST segment followed by cove plane T wave in leads V3, V4 or V5. The T in V6 is not inverted.

B11. Upward convexity of ST segment (2 mm or more at the point of maximum displacement) with terminal dipping in any lead except leads AVR, V1 or V2.

B12. Two or more records within a time interval of one month showing ST segment elevation followed by or in association with progressive deepening of T waves in any of the following leads: 1, 2, AVF, V3, V4, V5 or V6.

B13. T wave deeper than 10 mm in any of the following leads: 1, 2, AVF, V1 through V6.

B14. Relatively symmetrical T wave inversion in any three of the leads V2, V3, V4, V5, V6. The T wave is deeper than 2 mm in at least one of these leads.

Series C

C1. Q wave greater than 40% of R in any of leads 1, 2, V5 or V6.

C2. Q wave is present in leads 2, 3 and AVF. The Q in AVF is greater than 50% of R and Q2 is greater than 20% of R.

C3. 'Marked left axis deviation', as indicated by R/S ratio of less than 1/5 in lead 2, with slurred or notched R wave in leads 2, 3 and AVF and with T wave flat, notched, biphasic or inverted or with flat or sagging ST depression in any of the following leads: 1, 2, V4, V5 or V6. QRS does not exceed 0.11 sec.

C4. Low voltage as indicated by the sum of the QRS deflections in leads 1, 2 and 3 totalling less than 15 mm and the QRS deflection not exceeding 15 mm in any single chest lead, accompanied either by flattened, biphasic or inverted T waves or by ST segment depression of 0.5 mm or more in any of the following leads: 1, 2, V2 through V6. There are no spiked P waves greater than 4 mm in leads 1 or 2, and heart rate is not above 120.

C5. ST segment displacement 3 mm or greater at point of maximal deflection in any lead, provided that no R or S wave in any chest lead is greater than 30 mm and that the QRS is less than 0.12 sec, except for records in which ST segment elevation in V1-V3 proceeds with convexity downward immediately into tall, upright T waves.

C6. Horizontal ST depression of 0.5 mm or more at its maximum in any of the following leads: 1, V5 or V6. Heart rate does not exceed 120.

C7. ST segment elevation associated with inversion of the T wave in any of the following leads: 1, 2, AVF, V3 through V6. QRS is less than 0.12 sec.

C8. Inverted T wave 1 mm or greater which is relatively symmetrical in any of the following leads: 1, 2, V4, V5 or V6; or, the development of inverted or biphasic T wave in any one of these leads when previously upright; or, the reversion of an inverted or biphasic T wave in any of these leads to upright.

C9. T waves greater than 10 mm in any two chest leads.

Series D

D1. Left bundle branch block: Slurred, wide R waves, greater than 0.11 sec, with intrinsicoid deflection occurring at least 0.08 sec after beginning of R wave, and with inverted T in leads V5 or V6.

D1. Right bundle branch block; QRS is wider than 0.11 sec; RSR′ or QRS′ complex or notched wide R plus inverted T wave is present in lead V1. The first 0.04 sec of QRS is normal. T waves are normal in leads 1, V5 and V6.

D3. Indeterminate bundle branch block: QRS exceeds 0.11 sec, and definition given in D1 or D2 is not fulfilled.

D4. Incomplete A–V block, PR is 0.22 sec or greater; or 2nd degree A–V block—intermittent cardiac cycles containing a P wave and no related QRS–T complex.

D5. Complete A–V block.

Table AA2—Exclusions from application of ECG abnormalities in criteria for diagnosis

1. A general exclusion is applicable to all specified abnormalities mentioning Q waves (A1–A5, B1–B7, C1, C2) when the full pattern from all available records suggests that the Q waves represent a 'transition zone' phenomenon.
2. No other exclusions are considered applicable to A5.
3. No other exclusions are considered applicable to A1 or B1 if the Q is greater than 50% of R in lead 1, V5 or V6 in association with the described ST–T changes.
4. No other exclusions are considered applicable to A2 or B2 if the Q in lead 2 is greater than 50% of R in that lead in association with the described ST–T changes.
5. The circumstances under which hypertension*, valvular or congenital heart disease, and digitalis or quinidine are considered exclusions for specified abnormalities are outlined in Table AA3 of this Appendix.
6. The presence of other conditions which might produce the specified abnormalities (especially those dealing with ST and T changes) is always to be considered. Among these are: pericarditis, pericardial effusion, myocarditis, myxedema, chronic pulmonary disease, acute systemic infection, anemia, hemorrhage or shock, acute intracranial disease, cirrhosis, severe vomiting or diarrhea, hypokalemia, hyperkalemia, status post thoracotomy, etc. If in the opinion of the reviewing physician the observed ECG abnormalities may have been related to conditions other than CHD, the procedure indicated in 7 is followed.
7. In the presence of an excluding condition ECG abnormalities are given less weight in the criteria for diagnosis of myocardial infarction or possible myocardial infarction. Specifically:
   Series A abnormalities are given the weight of those in Series B.
   Series B abnormalities are given the weight of those in Series C.
   Abnormalities specified in Series C and Series D are given the weight of non-specified abnormalities.
   Non-specified abnormalities are equated to normal ECG findings.

* "Hypertension" is considered present as a possible cause for ECG abnormalities, if a systolic reading of 140+ or a diastolic reading of 90+ is obtained at the baseline examination or if diastolic readings of 90+ have been previously recorded in the HIP medical record.

Table AA3—Hypertension, valvular or congenital heart disease, digitalis and quinidine as exclusions for ECG abnormalities

ECG abnormality	Hypertension,* valvular or congenital heart disease exclude:	Digitalis, quinidine exclude:
A1 B1	Unless (a) R in lead 1 and R in AVL are each < 20 mm and the sum of S in V1 and R in V5 is < 35 mm and (b) ST segment is elevated in the lead with the abnormal Q wave	Unless ST segment is elevated in the lead with the abnormal Q wave
A2 B2	No	Unless T wave is upright in lead 1, V5 or V6
A3 (2) (i) A3 (2) (iii) and B3, parallel changes	No	Unless T wave is upright in lead V5 or V6.
A3 (2) (ii) and B3, parallel changes	Unless the sum of the S in lead V1 plus R in lead V5 is less than 35 mm	
A4 (2) (i)	Unless T is upright in lead V5 or V6	
A4 (2) (ii)	Unless the sum of S in V1 and R in V5 is < 35 mm	No
B4 (1) (i) or (iii) B4 (2) (i) or (iii)	Unless R wave is < 20 mm in all limb leads and T wave is upright in the V lead with the tallest R wave	Unless limb lead with the tallest R wave exhibits an upright T wave or ST segment elevation.
B5	Unless ST segment elevation reaches 3 mm at its maximum and the sum of S in lead V1 plus R in V5 is < 35 mm	
B8	Unless ST segment elevation (upward convexity) reaching 3 mm or more at its maximum is present in any two of the specified leads	
B9	No	Yes
B11	Yes	Yes
B14	Unless the T wave inversion is not limited to leads V4, V5 and V6	
C3 C5 C6	Yes	Yes
C8	Unless the inverted T waves noted at the time of a clinical episode are known to have been upright before or are again upright following the episode	Yes
Series D Non-specified	No for hypertension; yes for others Yes	Yes, except for digitalis with D1, D2 and D3

* "Hypertension" is considered present as a possible cause for ECG abnormalities, if a systolic reading of 140+ or a diastolic reading of 90+ is obtained at the baseline examination or if diastolic readings of 90+ have been previously recorded in the HIP medical record.

Table AA4—Definition of positive "acute phase"

A positive 'acute phase' is considered present if any *one* of the following conditions is met and there is no other disease to account for the abnormalities:

(a) SGOT is 55 or more
(b) SGOT is 40–54 and there is one other acute phase abnormality (fever, ESR or WBC)
(c) SGOT is under 40 or not known but there are at least *two* other acute phase abnormalities.

Definitions of abnormality for individual aspects of 'acute phase' phenomena:

Fever

Temperature over 100° for two consecutive days, or 101° or more on a single day.

Erythrocyte sedimentation rate

Considered abnormal for the acute phase definition if any *one* of the following conditions is met:

(a) Observed to rise from normal to high levels in the first week after suspected MI
(b) High in the first week of hospital stay and returns to borderline or normal by the end of the stay
(c) High in the first week of hospital stay and not done thereafter
(d) Borderline in the first week of hospital stay and normal later in the stay.

High, borderline and normal levels are defined in relation to the method used, as follows:

	High	Borderline	Normal
Wintrobe:	15+	10–14	< 10
Westergren:	30+	20–29	< 20

White blood count

A count exceeding 11,000 is considered abnormal without regard to the percentage of polys. A count between 9,000 and 11,000 with percentage polys exceeding 75 is also regarded as abnormal.

Table AA5—Definition of symptom patterns I and II

Symptom Pattern I

Pain or discomfort which fulfills *all* of the following minimum requirements:

1. Sensation is located in the precordium, epigastrium, arms, base of neck, or lower jaw
2. Nitrites, if tried, do not provide prompt relief
3. Sensation is prolonged (generally $\frac{1}{2}$ hr or more) or opiates are given for relief. If severity is mentioned, it is not described as 'mild'
4. *Either*: The character of the sensation is described in such terms as 'crushing,' 'squeezing', 'pressing', 'choking'
   Or: If described in other terms, the sensation is accompanied by one or more of the following: diaphoresis, collapse, sudden weakness, apprehension, dyspnea, syncope, or other signs or symptoms interpreted by a physician as shock or impending shock.

Symptom Pattern II

Minimum requirements consist of any *one* of the following:

1. An episode of sudden dyspnea*
2. An episode of syncope*
3. Symptoms or findings suggestive of arterial embolization*
4. Pain or discomfort which fails to meet the requirements specified for Symptom Pattern I, but does fulfill the following *three* conditions:
   (a) Sensation is located in any part of the chest (including back of chest), epigastrium, base of neck, lower jaw or arms
   (b) Nitrites, if tried, do not provide prompt relief
   (c) *Either*: Sensation is prolonged and not described as 'mild'
   Or: Opiates are given for relief,
   Or: Sensation is accompanied by one or more of the following: diaphoresis, collapse, sudden weakness, apprehension, other signs or symptoms interpreted by a physician as shock or impending shock.

* Patients with hypertension, valvular heart disease, or atrial fibrillation are considered to have other possible cause for such symptoms and are excluded from meeting these requirements on this basis.

Table AA6—Scoring of elements of the angina history

LOCATION			
Substernal	+3	Localized to apex	−1
Precordial	+2		
Left chest, base of neck, lower jaw, epigastrium	+1		
RADIATION			
Either arm	+2		
Shoulder, back, neck, lower jaw (arm not mentioned)	+1		
CHARACTER			
Crushing, pressing, squeezing	+3	Sticking, stabbing, pinprick, catching	−1
Heaviness or tightness	+2		
SEVERITY			
Severe	+2*		
Moderate	+1*		
RELATIONSHIP TO EFFORT			
Precipitated by effort and response is consistent	+5	Not related to effort	−5
Usually but not always related to effort	+3		
OTHER PRECIPITANTS			
Emotion	+1	Bodily movement, specified, or interpreted by examining MD as musculoskeletal	−5
Cold weather	+1	Musculoskeletal etiology suggested to MD by other findings	−3
		Bodily movement, not specified and uninterpreted by examining MD	−2
		Breathing	−5
		Meals and GI pathology is suspected by examining MD	−3
USUAL DURATION			
1–4 min	+3†	More than 1/2 hr	−5‡
5–10 min	+2		
RELIEF BY REST			
Yes, in 5 min or less	+2	Yes, but takes more than 1/2 hr	−5‡
		No, no further information	−3‡§
RELIEF BY NTG			
Yes, in less than 5 min	+5	NTG tried, effective dose, no relief or only after > 1/2 hr	−5
Yes, in 5–10 min	+3	NTG tried, unknown if effective dose, no relief or only after > 1/2 hr	−2
RELIEF BY OTHER			
Improved with long-acting nitrites	+1	No improvement with long-acting nitrites	−1
		Relieved by antacids	−5

* Score is entered for severity only if some positive score has been entered for location, radiation or character.

† Fleeting pain, characterized as lasting only for seconds, produces *no* score.

‡ Only the *single* highest negative score from these items is tallied.

§ If "no relief by rest" seems clearly related to the fact that the patient always takes NTG, no negative score is applied here.

APPENDIX B

Sampling Errors

Incidence rates in this report represent the combined experience over a three-year period; i.e., to calculate an incidence rate for a specified category, the aggregate number of new cases identified over this period is divided by the combined results of the three annual sample surveys for the relevant exposed-to-risk population (adjusted for the 4 per cent sampling ratio and the over-all nonresponse factor). In determining sampling errors associated with these rates, it was assumed that the population under observation is a random sample from a theoretical infinitely large universe. Accordingly, both the numerator and denominator of an incidence rate contribute to the measure of sampling variability, even though the numerator is a total count of the defined CHD events among all persons enrolled in the participating medical groups who met the age and period of enrollment criteria.

Table B1 provides standard errors for a wide range of incidence rates. These were calculated using the formula

$$s_i = R_i \sqrt{\frac{s^2 n_i}{n^2_i} + \frac{s^2 d_i}{d^2_i}}$$

$$= R_i \sqrt{\frac{1}{n_i} + \frac{1}{d_i} - \frac{1}{D}}, \text{ where}$$

s_i = standard error of incidence rate (R_i) for specified characteristic,

n_i = numerator count for characteristic (Series N tables),

d_i = denominator sample count for characteristic (Series D tables), and

D = sample count of total population at risk for MI. (For computational convenience a constant value was used for $\frac{1}{D}$, i.e. $\frac{1}{3{,}928}$.

(The number 3,928 represents the total males in the sample at risk for MI. Use of 3,829 males at risk for angina or possible MI, or of 4,301 total females at risk for MI, or of 4.273 females at risk for angina or possible MI would not change the s_i values.)

By far the more important component of the above formula is the sampling error associated with the numerator of an incidence rate. In fact, an adequate estimate of the standard error of rates of about 3 per 1,000 or less could be obtained from

$$R_i \sqrt{\frac{1}{n_i}}, \text{ where}$$

n_i is the numerator frequency and R_i is the incidence rate. The contribution of the denominator to sampling error becomes increasingly important as the incidence rate rises. However, for all but very few of the rates in the current report the denominator accounts for more than 10 per cent of the standard error. Refining the standard error formula to reflect the fact that a one in four subsample of nonrespondents was used to increase the response rate from about 72 per cent to approximately 83 per cent would not have changed this situation perceptibly.

Table B2 is a nomographic device to estimate the standard error of the difference between two incidence rates. Its main value is to avoid the task of squaring standard errors to obtain the sum of variances and then taking the square root of the result ($s_d = \sqrt{s_1^2 + s_2^2}$). But there is no particular advantage to the nomographic device if the reader has readily available suitable tables of squares and square roots. In Table B2 the "factor" corresponds to the term

$$\frac{\sqrt{s_1^2 + s_2^2}}{s_1 + s_2}.$$

The nomograph is obtained by generating a "factor" related to a specific ratio,

$$\frac{s_1}{s_1 - s_2}.$$

If $\frac{s_1}{s_1 - s_2} = k$ (constant), then

$$\frac{\sqrt{s_1^2 + s_2^2}}{s_1 + s_2} = \frac{\sqrt{2k^2 - 2k + 1}}{2k - 1} = \text{factor}.$$

An example of the use of the table in a test of statistical significance is given below.

Incidence rates per 1,000 to be compared:

3.00 ± 0.699
5.00 ± 0.559

$s_1 = 0.699,\ s_2 = 0.559$

$s_1 - s_2 = 0.140,\ s_1 + s_2 = 1.258$

$\frac{s_1}{s_1 - s_2} = 4.993$. Factor $= 0.712$

Factor x $(s_1 + s_2) = 0.896 =$

standard error of difference between the rates.

$$t = \frac{2.00}{0.896} = 2.23,$$

statistically significant at the 0.95 level of confidence.

Table B1—Standard errors of annual incidence rates per 1,000

Incidence rate per 1,000	Numerator Frequency 5	6	7	8	9	10	20	30	40	50	60	70	80	90	100	200	300	400	500	600
0.10	.045	.041	.038	.035	.033	.032	.022	.018												
0.20	.090	.082	.076	.071	.067	.063	.045	.036	.032											
0.30	.135	.123	.114	.106	.100	.095	.067	.055	.047	.042										
0.40	.180	.164	.152	.142	.134	.127	.090	.073	.063	.057	.052									
0.50	.225	.205	.190	.178	.168	.159	.112	.092	.079	.071	.065	.060								
0.60	.271	.247	.229	.214	.202	.191	.135	.110	.095	.085	.078	.072	.067							
0.70	.316	.289	.267	.250	.236	.223	.158	.129	.111	.099	.091	.084	.078	.074						
0.80	.362	.330	.306	.286	.270	.256	.181	.147	.127	.114	.104	.096	.090	.084	.080					
0.90	.408	.372	.344	.322	.304	.288	.203	.166	.143	.128	.117	.108	.101	.095	.090					
1.00	.454	.414	.383	.358	.338	.320	.226	.185	.160	.143	.130	.120	.112	.106	.100	.070				
2.00	.920	.840	.778	.727	.686	.650	.459	.375	.324	.289	.264	.244	.228	.215	.203	.142	.115			
3.00	1.400	1.278	1.183	1.106	1.043	.989	.699	.570	.493	.440	.401	.371	.347	.327	.310	.216	.174	.149		
4.00	1.892	1.727	1.599	1.495	1.410	1.337	.944	.770	.666	.595	.543	.502	.469	.442	.419	.292	.236	.202	.178	
5.00	2.397	2.187	2.025	1.894	1.785	1.694	1.196	.976	.844	.754	.688	.636	.594	.559	.530	.371	.299	.256	.226	.204
6.00	2.913	2.659	2.461	2.302	2.171	2.058	1.454	1.186	1.026	.917	.836	.773	.723	.680	.645	.451	.364	.311	.275	.248
7.00	3.441	3.141	2.908	2.720	2.564	2.432	1.718	1.401	1.212	1.083	.988	.913	.854	.804	.762	.533	.430	.368	.326	.294
8.00	3.982	3.635	3.365	3.147	2.966	2.814	1.988	1.621	1.403	1.253	1.143	1.057	.988	.930	.882	.617	.498	.427	.377	.341
9.00	4.533	4.138	3.831	3.583	3.378	3.204	2.263	1.846	1.597	1.427	1.301	1.204	1.125	1.060	1.004	.703	.568	.486	.430	.388
10.00	5.096	4.652	4.037	4.027	3.797	3.601	2.545	2.076	1.796	1.605	1.463	1.354	1.265	1.191	1.129	.790	.639	.547	.484	.437
20.00	11.308	10.323	9.556	8.938	8.426	7.993	5.648	4.608	3.987	3.564	3.250	3.007	2.811	2.647	2.510	1.760	1.425	1.224	1.085	.982
30.00	18.486	16.875	15.623	14.611	13.777	13.066	9.234	7.535	6.521	5.829	5.317	4.919	4.599	4.333	4.108	2.885	2.339	2.011	1.786	1.619

Table B2—Estimate of the standard error of the difference between two annual incidence rates per 1,000

Computation: Let s_1 = larger of the two standard errors, and

$s_1 - s_2$ = difference between the two standard errors

(1) Divide the larger of the two standard errors by the difference $\left(\frac{s_1}{s_1 - s_2}\right)$

(2) Locate appropriate factor in table below and multiply the sum of the two standard errors $(s_1 + s_2)$ by this factor.

$\frac{s_1}{s_1 - s_2}$	Factor
1.00	1.000
1.01	.990
1.02	.981
1.03	.972
1.04	.964
1.05	.956
1.06	.948
1.07	.941
1.08	.934
1.09	.927
1.10	.920
1.12	.909
1.14	.897
1.16	.887
1.18	.878
1.20	.869
1.22	.861
1.24	.853
1.26	.846
1.28	.840
1.30	.834
1.32	.828
1.34	.823
1.36	.818
1.38	.813
1.40	.809
1.45	.799
1.50	.791
1.55	.783

$\frac{s_1}{s_1 - s_2}$	Factor
1.60	.777
1.70	.766
1.80	.758
1.90	.751
2.00	.745
2.10	.741
2.20	.737
2.30	.734
2.40	.731
2.50	.729
3.00	.721
4.00	.714
5.00	.712
10.00	.708
20.00+	.707

APPENDIX C

Nonsampling Errors

I. The Mail Survey as a Source of Data for the Population at Risk

Information on the characteristics of the population at risk for development of new manifestations of CHD was obtained in this study from a series of three annual mail surveys of the insured population enrolled in the participating medical groups. The mail survey questionnaire was designed (1) to elicit standard demographic information; (2) to identify from the answers to a series of questions on heart disease and chest pain those respondents whose medical records were to be reviewed in order to establish risk status for manifestations of CHD; and (3) to collect information on a number of variables for which there was interest in exploring possible associations with the incidence of CHD.

In April of each of the years 1962-1964 a nonrepetitive 4 per cent sample of the insured population (aged 25-64 and with at least two years of continuous prior coverage in HIP) was surveyed. Respondents no longer at risk for the development of new manifestations of CHD in accordance with the study criteria were removed, and the resultant data are viewed as descriptive of the average population exposed to risk over the year extending from the November preceding the given survey through the October following it. The rates presented in this report are based on the combined experience of the 1962, 1963, and 1964 mail surveys—the appropriate denominator for the case-finding period November 1, 1961-October 31, 1964.

Exploration of Nonresponse Bias—The over-all response for the three mail surveys combined was 83 per cent, with little variation between the years (83.0 per cent for 1962, 83.8 for 1963, and 82.2 for 1964). The first wave of respondents constituted 72.4 per cent of the total sample, and in all three years a 25 per cent sample of the original nonresponse was subjected to intensive follow-up by letter, telephone, and home visit. To explore possible bias introduced by the nonresponse the characteristics of the two waves of respondents in the 1962 and 1963 surveys combined were examined separately. The examination was focused on respondents aged 35-64, the age range pertinent to the incidence data. Late respondents among both males and females were somewhat younger than the early respondents (proportion of persons aged 35-44 about 5 per cent higher). There was also a higher proportion of nonwhites and of foreign-born among the late respondents (about 10 per cent higher than early respondents in both these respects). There were relatively more Protestants and Catholics and relatively fewer Jews in late as compared with early respondents. Distribution of early and late respondents by smoking habits was practically identical for the males, while late respondents among females contained about 6 per cent more cigarette smokers than the early respondents. No consistent pattern of difference was discernible for male early and late respondents distributed by occupation and by job-connected physical activity.

If it is assumed that the 17 per cent nonresponse has the characteristics of the late respondents, the effect on the distribution of the surveyed population with respect to variables under consideration in this report is very small. This computation is shown for demographic characteristics in Table C1, for smoking and physical activity off the job in Table C2, and for physical activity connected with the job and occupation in Table C3. It seems reasonable to conclude that the incidence data here presented would not be appreciably affected by nonresponse bias.

Identification of CHD Risk Status

Among Survey Respondents—The medical records of about 10 per cent of the respondents to the three mail surveys had already been abstracted in the course of the study's regular case-finding procedures at the time of return of the questionnaires. Chart abstracting for these individuals was brought up to date in all instances where the date of last medical record review preceded the survey date. Additional medical record abstracting was done for all respondents reporting the presence of heart disease (other than rheumatic heart disease or "murmur") and for all who reported chest pain, unless it was also stated that no medical care had ever been sought in connection with this complaint. The abstracted medical records for a total of about 15 per cent of the respondents to the three surveys were reviewed centrally, and the same operational rules applied which were used to decide which patients should receive the baseline examination, which should be returned to risk, and which excluded from risk.

On the basis of this record review about 3 per cent of the mail survey respondents were classified as having already sustained an episode of myocardial infarction, of possible myocardial infarction, or a diagnosis of angina. In tabulations for the denominators of the incidence rates in this report those judged to have had a highly probable or probable MI were omitted entirely, while patients judged to have had a possible MI or angina were included in the population at risk for MI but excluded from that at risk for angina or possible MI.

Comparability of Information from Mail Survey and Personal Interview Sources—Since different methods are used in this study to obtain information for the numerators and the denominators entering into rates of incidence of CHD, the possibility of systematic bias in constructing the rates is an issue of some importance. To examine this issue the study's methodology provided for comparison between mail survey responses and responses on personal interview for those individuals in the cumulative mail survey sample who also, over the course of the study period, were scheduled for baseline evaluation examinations because the possibility of a new manifestation of CHD was suspected.

Between February, 1962, and October, 1966, both mail survey schedules and personal interviews for the same individuals were obtained for a total of 104 males and 52 females. The comparison to be presented is one between the two instruments as sources of data, and not between actual numerator and denominator data. That is, mail survey schedules are included in the comparison whether or not the individuals were removed from the population at risk for incidence of new CHD manifestations. Similarly, interviews with patients evaluated at a baseline examination are used whether or not a new manifestation of CHD was established. Of the 104 interviewed males only 57 are in the cohorts under follow-up for prognosis of MI, angina, or possible MI; 20 of the 52 interviewed females are in these categories.

The comparison was made by coding information from the interview *reconstructed to the date of mail survey* to whatever extent this was possible. The relative dates of mail survey and interview were as follows:

	Males	Females
Interview after mail survey	83	38
Months elapsed:		
Less than 6	16	9
6–11	16	10
12–17	14	9
18–23	11	3
24–29	12	5
30–35	7	—
36+	7	2
Interview before mail survey	21	14
Months elapsed:		
Less than 7	14	11
7+	7	3

These time intervals do not affect comparisons involving color, place of birth, religion, education, or age as of mail survey date. Problems do, however, arise with respect to characteristics subject to change over time, especially those for which change is often imposed by physician management or patient reaction after a diagnosis of coronary heart disease. For such characteristics the personal interview of patients receiving the study's baseline examination was designed to elicit information as of the time *just prior to diagnosis* as well as of the date of interview. Questioning on smoking habits, physical activities on and off the job, job characteristics, and body weight was organized in a general format which could get information as of the time just prior to hospitalization for a first MI, for example, or as of the time just prior to first complaint of recurring chest pain subsequently considered to meet the study's criteria for definite angina. Patients examined at baseline for whom no hospitalized episode or onset of new symptomatology could be established were asked about such characteristics as of the date of baseline and were then probed with a series of questions about any changes that had occurred *within the six months preceding the examination.*

Many of the patients who enter into the comparison of mail survey and interview information (45 per cent of the males and 62 per cent of the females) were either returned to risk or excluded from the prognosis cohorts on the basis of the findings at the baseline examination. For these individuals, if the mail survey preceded the baseline interview by more than six months and if changes in characteristics or habits had in fact occurred, there would be no way of reconstructing to the date of mail survey from the data collected at personal interview. For the 35 patients interviewed *before* the date of mail survey there was of course no possibility of controlling for real changes in habits between the two dates.

The theoretical possibility of exact reconstruction from interview information to status as of mail survey date is therefore seriously limited for a substantial proportion of the individuals who were both respondents to the mail survey and patients interviewed at baseline examination. In the accompanying tables (C4 through C7) distributions by the specified characteristics obtained from mail survey and interview information from the same individuals have therefore in some instances been limited to groups restricted to a defined time interval elapsed between mail survey and interview.

Excellent agreement between the two instruments in the information about demographic characteristics—age, color, place of birth, religion, education—was found for both men and women, and there was also good agreement in the reporting of occupation on the part of the working men (Table C4).

Changes in smoking habits in the months immediately preceding baseline interview were very commonly reported by the men who were examined. Comparison between interview and mail survey responses was therefore restricted to two groups of men shown in Table C5—first, all men for whom the interview followed the mail survey regardless of the interval and men for whom the interview took place within the six months preceding it, and, second, men interviewed within 18 months following mail survey or within six months preceding it. Good agreement in reporting of smoking habits is apparent for the latter group, even when smoking habits are classified in detail. For the group with the wider time span between mail survey and interview, the degree of agreement, as expected, is less—especially when smoking habits are characterized by amount of cigarettes smoked.

It is possible that a bias operated toward understatement of the number of smokers of two or more packs of cigarettes daily from mail survey information, but the frequencies in this category are too small to allow any "estimate" of the extent of such postulated bias. Nevertheless, since the possibility exists that the incidence rates of CHD computed for these *heavy* smokers may be somewhat inflated through the operation of such a bias, caution needs to exercised in estimating the magnitude of the disadvantage of the men smoking two or more packs daily. The rates for cigarette smokers as a whole in comparison with nonsmokers are more reliable.

Construction of the physical activity indexes in relation to which incidence data have been developed for this report is described in detail in Appendix D. The assignment of weights for specified answers to the questioning in this area from the mail survey or interview schedules reflects judgments made by the investigators about the relative levels of physical activity to be inferred from the respondent's choice of the terminology offered in the questionnaires. There is no definitive way, within the context of this study, to measure differences between responses to questions on physical activity in an interview situation and those obtained through a mail survey. It could be argued that not only does the manner of obtaining the information influence the response, but that the timing and setting of the interview (i.e., in a doctor's office and, frequently, after a diagnosis of heart disease has been made) might affect in important ways the patient's responses to questions about prior physical activity.

At the same time, there is the possibility that real change in over-all level of physical activity occurred over a period of four years in a group of predominantly middle-aged men. Thus, if all men who were interviewed after or within six months preceding the mail survey are compared as to responses leading to the characterization "least active" or "more active" from mail survey and from interview, there is a wide discrepancy in the proportion classified as least active—18 per cent from mail survey information and 36 per cent from interview information (Table C4). As the time elapsed between mail survey and interview is reduced, the proportion of least active men from mail survey information rises consistently until, for the last group examined in the table (interview within six months after mail survey) 33 per cent of the classified men are judged least active from survey information and 31 per cent from personal interview.

In view of these data it would seem prudent to conclude that some bias may have operated in the direction of overstating physical activities on mail survey, or understating them on personal interview. To test the effect of this possible bias an estimate was made from the comparison of mail survey and interview information for the 30 men who were interviewed within six months before or after mail survey (the third group shown in Table C6). These data produce an estimate of 4.7 per cent overstatement for least active men and an understatement of 5.4 per cent for more active men on personal interview as compared with mail survey. Applying this estimate as a "correction" to the incidence rates by physical activity in no case reduces the differential between "least active" and other men sufficiently to eliminate the statistical significance of the difference.

Data comparing relative weight and weight history classifications based on mail survey and interview information are shown in Table C7. The relative weight, based on reported height, age, and estimated weight as of mail survey date, is similarly distributed for both men and women from the two sources of information. Greater variability, as expected, is found in comparing the distributions by weight history: since this classification is based on the respondent's reported maximum and minimum adult weights, and the ages corresponding to these weights, the interview provided no way of reconstructing to the weight history that would have been given by the patient at the time of mail survey. While a bias operating to understate the highest weight gain category on mail survey (or to overstate it on interview) cannot be ruled out, no effect of sufficient magnitude to eliminate the differentials found in the incidence rates is suggested.

Handling of "Not Answered" Categories—Incidence rates in relation to most of the variables covered in this report have been computed by dividing the numerator count for a specified category by the denominator count for that category, inflated to provide for sampling and nonresponse. Persons in the "not answered" categories of the distributions have been omitted from the computations in all instances where the "not answered" group represented a similar proportion of both numerator and denominator or where the effect of distributing the "not answered" would have been negligible. Frequencies for the "not answered" categories are in all cases given in the detailed numerator and denominator tables.

However, because it was desired to compute rates for men "adjusted" for (a) age and smoking habits and (b) age and over-all physical activity level, it was necessary in these two instances to distribute the unknowns in the numerators and denominators before computing the age-smoking-specific and the age-physical-activity-specific rates used in the adjustment. Testing of a variety of computational routines all produced very similar results. The method adopted was to distribute the persons "not answered" with regard to smoking or physical activity within each of the age groups 35-44, 45-54, and 55-64 to correspond with the distribution of the known categories for each subdivision of the other variable under consideration.

II. Comparability of Information from Self-Respondents with that from Next of Kin

Characteristics of persons entering into the numerators of incidence rates for MIs not fatal within 48 hours, for angina, and for possible MIs were established through interviews with self-respondents at the baseline examination. But for those persons succumbing to a first MI within 48 hours of onset numerator information came from interviews with next of kin. Differentials in incidence of MI discussed in this report in relation to the variables covered were frequently concentrated among those MIs *not* rapidly fatal (for example, color, religion, relative weight, weight history). Or, in relation to age, sex, and smoking habits, for example, differentials were noted both among the rapidly fatal and the other MIs.

However, in relation to physical activity level, a much larger disadvantage was demonstrated by the least active men with respect to those MIs which were fatal within 48 hours. If it were true that self-respondents (on interview or mail survey) were biased toward *overstating* their level of physical activity, or that next of kin, in general, *understated* the usual activity of the men who died within 48 hours of a first MI, a spurious relationship between physical inactivity and elevated incidence of rapidly fatal first MI could result. In connection with this issue there were available in the HIP study 41 men who survived more than one month after initial myocardial infarction and who refused the baseline examination. Telephone interviews to determine characteristics at the time of MI were conducted in 23 of these cases with the patients themselves, and in 18 with their wives as respondents. As shown in Table C8, a higher proportion of the men who were self-respondents were classified as least active than was the case where wives were the informants. Although there is no precise way to determine the comparability between these two groups of men, the data represent the only direct evidence available on the issue, and provide no support for an assumption that sedentary men report themselves as being more active than do their wives.

Table C1—Estimate of the effect of mail survey nonresponse on the distribution of the population at risk with respect to selected demographic characteristics

Characteristic	Males		Females	
	As tabulated	Estimated total pop.*	As tabulated	Estimated total pop.*
Number of persons	2713	3262	3046	3676
Per cent	100.0	100.0	100.0	100.0
Age				
35-44	34.2	35.1	34.4	35.1
45-54	35.5	34.9	39.7	39.0
55-64	30.2	30.0	25.9	26.0
Color				
White	87.7	86.3	85.4	84.4
Work status				
Working or worked in past 5 yrs	97.2	97.2	65.2	65.4
Religion				
Catholic	46.6	47.7	40.2	41.9
Jewish	33.3	31.5	38.7	35.9
Protestant	15.7	16.5	17.2	18.4
Other or none	3.4	3.6	3.1	2.7
Not answered	0.9	0.7	0.9	1.1
Place of birth				
Continental U.S.	74.9	73.6	75.3	73.7
Latin America	4.6	5.1	3.4	3.9
Western Europe	6.8	7.8	7.2	8.2
Eastern Europe	6.0	5.6	6.9	6.0
Other	4.6	4.6	4.8	5.7
Not answered	3.1	3.4	2.5	2.5

* Estimated by distributing nonrespondents for the 1962 and 1963 surveys in accordance with the characteristics established for late respondents (subsample of the original nonrespondent group).

Table C2—Estimate of the effect of mail survey nonresponse on the distribution of the population at risk with respect to smoking habits and physical activity off the job

Characteristic	Males		Females	
	As tabulated	Estimated total pop.*	As tabulated	Estimated total pop.*
Smoking category				
Cigarette smokers	47.4	47.3	39.6	40.5
1+ packs	36.7	37.2	20.9	20.0
2+ packs	5.9	5.5	2.2	2.1
1 or 1½ packs	30.7	31.7	18.6	17.9
Less than 1 pack	10.7	10.1	18.7	20.5
Pipe/cigar smokers only	9.9	9.9	-	-
Non-smokers†	39.7	39.5	59.1	58.5
Some smoking history	20.8	20.8	10.4	9.8
Never smoked	18.1	17.9	46.9	46.8
Unclassified	2.9	3.2	1.3	1.1
Physical activity off the job‡				
Class 1 (least active)	12.5	11.8		
Class 2	28.3	29.4		
Class 3	26.1	27.8		
Class 4 (most active)	21.0	20.4		
Unclassified	12.0	10.6		

* See footnote to Table C1.
† Includes unknown if ever smoked.
‡ For details of classification see Appendix D.

Table C3—Estimate of the effect of mail survey nonresponse on the distribution of the working male population with respect to job characteristics

	As tabulated	Estimated total pop.*
Number of persons	2636	3172
Per cent	100.0	100.0
Job-connected physical activity†		
Class 1 (least active)	28.5	28.6
Class 2	26.5	27.3
Class 3	23.1	22.3
Class 4 (most active)	16.7	16.1
Unclassified	5.2	5.7
Occupation		
Professional and technical	21.4	21.9
Managerial	8.4	8.4
Clerical	11.0	10.9
Sales	2.2	1.9
Craftsmen, etc.	15.1	14.6
Operatives, etc.	14.8	15.3
Service workers	15.9	16.7
Laborers	6.0	5.8
Not answered	5.3	4.6

* See footnote to Table C1.
† For details of classification see Appendix D.

Table C4—Comparison of mail survey and interview information on demographic characteristics—males and females

	Males		Females	
	Distribution from		Distribution from	
	Mail survey	Inter-view	Mail survey	Inter-view
Total	104	104	52	52
Age				
Under 35	1	1		
35-44	17	17	5	5
45-54	44	44	21	22
55-64	41	42	26	25
Not answered	1	-		
Color				
White	94	95	46	48
Nonwhite	9	9	3	3
Not answered	1	-	3	1
Place of birth				
Continental U.S.	82	82	32	31
Latin America	4	4	1	2
Europe	15	17	17	19
Other	1	1		
Not answered	2	-	2	-
Religion				
Catholic	42	43	21	19
Jewish	43	44	25	27
Protestant	16	16	4	5
Other	1	1	2	1
Not answered	2	-		
Education				
Elementary school or less	24	25	20	21
Some high school	34	33	20	19
Some college	45	46	11	11
Not answered	1	-	1	1
Occupation				
Professional and technical	29	28		
Managers and proprietors	11	13		
Clerical and sales	15	15		
Craftsmen, operatives	23	30		
Service and laborers	6	4		
Not answered	6	-		

Table C5—Comparison of mail survey and interview information on smoking habits—males

	Interview after mail survey or less than 7 months before		Interview within 18 months after mail survey or less than 7 months before	
	Distribution from		Distribution from	
	Mail survey	Inter-view	Mail survey	Inter-view
Total	97	97	60	60
Broad classification				
Cigarette smokers	40	39	20	19
Pipe/cigar smokers	16	20	12	12
Non-smokers	40	37	28	28
Not classified	1	1	-	1
Detailed classification				
Cigarette smokers				
2+ packs	5	9	3	4
1 or 1½ packs	17	19	8	8
Less than 1 pack	18	11	9	7
Not cigarette smokers				
Smoked cigs past 5 yrs	12	13	8	10
Other smoking history	35	34	24	21
Never smoked	9	10	8	9
Not classified	1	1	-	1

Table C6—Comparison of mail survey and interview information on over-all physical activity, by specified time periods elapsed between mail survey and interview—males

Definition of comparison group; overall physical activity level	Maximum number of mos. between mail survey and interview	Distribution from Mail survey	Distribution from Interview	Least active as % of total classified Mail survey	Least active as % of total classified Interview
Interview after mail survey or less than 7 months before	50	97	97		
Least active		15	30	17.9	35.7
More active		73	63		
Not classified		9	4		
Interview within 18 months after mail survey or less than 7 months before	18	60	60		
Least active		13	20	24.1	33.3
More active		41	40		
Not classified		6	-		
Interview within 6 months after mail survey or less than 7 months before	6	30	30		
Least active		8	10	28.6	33.3
More active		20	20		
Not classified		2	-		
Interview within 6 months after mail survey	6	16	16		
Least active		5	5	33.3	31.3
More active		10	11		
Not classified		1	-		

Table C7—Comparison of mail survey and interview information on relative weight and weight history—males and females

	Males		Females	
	Distribution from		Distribution from	
	Mail survey	Inter-view	Mail survey	Inter-view
Total	104	104	52	52
Relative weight				
Less than 95	22	19	17	17
95-114	62	63	25	23
115+	19	21	9	12
Not classified	1	1	1	-
Weight history				
Percentage gain since age 25:				
Less than 10	7	9	2	4
10-19	21	17	16	14
20+	43	50	17	24
Age at maximum weight same or less than age at minimum weight	17	23	13	10
Not classified	16	5	4	-

Table C8—Men surviving more than one month after first MI who refused baseline evaluation, classified by physical activity level at time of MI on the basis of telephone interviews: comparison of self-respondents and next of kin informants (wives)

	Self-respondents			Next of kin informants		
	Total	Age at MI		Total	Age at MI	
		Under 55	55+		Under 55	55+
Total interviews	23	14	9	18	13	5
Physical activity (PA) not classified, insufficient information	1	1	-	2	1	1
Total, PA classified	22	13	9	16	12	4
Least active	6	4	2	3	3	-
More active	16	9	7	13	9	4
Age-adjusted % least active		27.8			16.4	
Patients under 55 only, % least active		30.8			25.0	

APPENDIX D

Classification of Physical Activity

The classifications of physical activity are limited to men. Both over-all and job-connected physical activity classifications are applicable only to those men known to have been employed in the five years preceding the specified diagnosis (numerator) or the given mail survey (denominator).

Job-connected physical activity (PAj). Four classes are defined in terms of the following ranges of accumulated scores for the six questionnaire items shown in Table DD1:

PAj class	Accumulated score
1 Least active	1–10
2 First intermediate	11–14
3 Second intermediate	15–18
4 Most active	19–28

Off-job physical activity (PAoj). Four classes are defined in terms of the following ranges of accumulated scores for the four questionnaire items shown in Table DD2:

PAoj class	Accumulated score
1 Least active	0–1
2 First intermediate	2–3
3 Second intermediate	4–5
4 Most active	6–10

Over-all physical activity (PAx). Three classes are defined in terms of the following specified combinations of job-connected and off-job physical activity classes:

PAx class	PAj class	PAoj class
1 Least active	1	1 or 2
	2	1
2 Intermediate	1	3
	2	2 or 3
	3	1, 2, or 3
3 Most active	4	All classes
	Other	4

An alternative classification of over-all physical activity (PAx′) is defined as follows:

PAx′ class	PAj class	PAoj class
1 Least active	1 or 2	1 or 2
2 First intermediate	3 or 4	1 or 2
3 Second intermediate	1 or 2	3 or 4
4 Most active	3 or 4	3 or 4

Table DD1—Job-connected physical activity questions

Question	Answer	Assigned weight
Time on job spent sitting	Practically all	0
	More than ½	1
	About ½	2
	Less than ½	3
	Almost none	4
Time on job spent walking	Almost none	0
	Less than ½	1
	About ½	2
	More than ½	3
	Practically all	4
Walking getting to and from job	None or less than 1 block	0
	1 or 2 blocks	1
	3 or 4 blocks	2
	5 to 9 blocks	3
	10 to 19 blocks	4
	20 to 39 blocks (1 mile, not 2)	5
	40+ blocks (2+ miles)	6
Transportation to and from job	None	0
	Car a/o bus a/o railroad a/o ferry	1
	Subway	2
	Subway+one or more other modes of transportation	3
Lifting or carrying heavy things	Very infrequently or never	0
	Sometimes	3
	Frequently	6
Hours on job	Less than 25	1
	25–34	2
	35–40	3
	41–50	4
	51+	5

Table DD2—Off-job physical activity questions

Item	Frequently	Sometimes	Very infrequently or never
Take walks in good weather	2	1	0
Work around house or apartment	2	1	0
Gardening in spring or summer	2	1	0
Take part in sports			
Active ball game other than golf, bowling, pool or billiards is mentioned	4	3	0
Other	3	2	0